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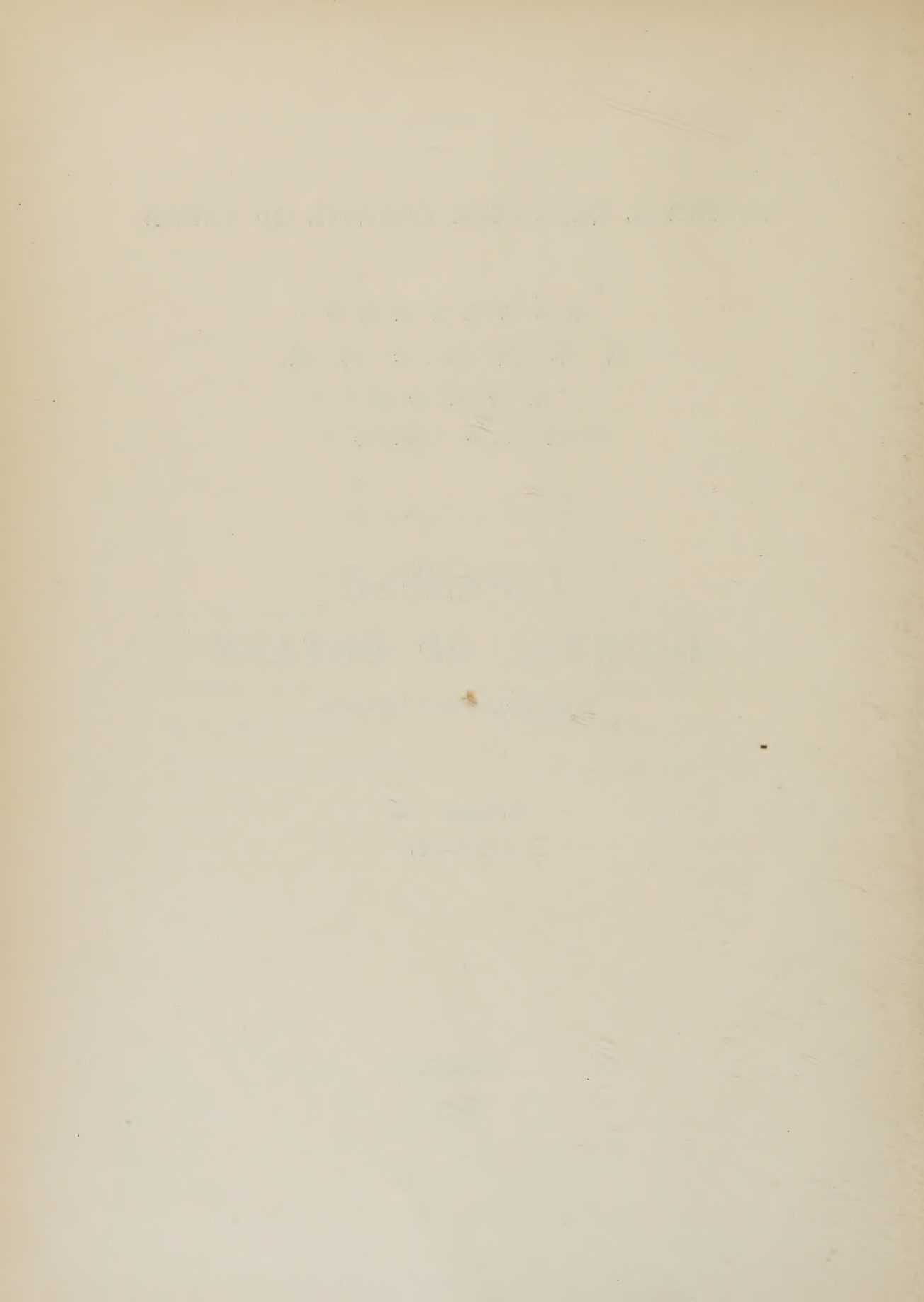
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On the Structure of Some Ancient, but still Viable Fruits of Indian Lotus, with Special Reference to Their Prolonged Dormancy⁽¹⁾

By Ichiro OHGA

With Plate I and 3 Text-figures

(Received June 23, 1925)

Introduction

The writer has had the opportunity of studying the structure of some very old lotus fruits, probably of the Indian Lotus, *Nelumbo nucifera* GAERTN. (*Nelumbium speciosum* WILLD.), the embryos of which have been proved to be still viable under suitable conditions. The extreme age of these fruits and the fact that they have retained their vitality for at least several centuries give them a peculiar botanical interest. They appear to be the oldest viable seeds thus far known to the scientific world and are therefore specially interesting as an example of the protracted dormancy of living protoplasm in the embryos of seeds. The present paper gives some of the results of the writer's studies on these old lotus fruits and of his comparative studies on the recent fruits of the Indian lotus which now grows in Japan and China.

These studies were begun in the writer's laboratory of the Educational College at Dairen, Manchuria, were continued at the University of Tokyo and have been brought to the present stage in the Laboratory of Plant Physiology of the Johns Hopkins University at Baltimore. The writer wishes to express his gratitude to Professor DUNCAN S. JOHNSON and Professor BURTON E. LIVINGSTON, of the Johns Hopkins University, especially for helpful criticism and guidance. Professor CHARLES A. SHULL of the University of Chicago, also helped greatly especially with the references to the literature, when he was working in Professor LIVINGSTON's laboratory in the autumn of 1923. The kindness and hearty cooperation of Mr. and Mrs. S. LIU and Mr. K. UNUMA of Pulantien, Manchuria, from whose land the ancient lotus

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fruits were gathered, are also to be mentioned here with appreciative gratitude. Prof. Y. YABE of the Women's Higher Normal College in Tokyo, Mr. J. OTA of the Peer's Girls' School in Tokyo, Mr. S. ONODERA, Otaki Middle School in Chiba Prefecture near Tokyo, very kindly supplied the writer with a number of new lotus fruits from Japan.

Origin of the Ancient Fruits

The old lotus fruits here considered occur in a prehistoric peat bed in the Pulantien Basin, in South Manchuria. Their occurrence has been reported in two earlier papers.⁽¹⁾⁽²⁾ •

In a report on the geology of the Kwantung Leased Territory, MURAKAMI⁽³⁾ gives the following geological information concerning the Pulantien Basin. The rocks of the Basin, alternate layers of quartzite and quartzite-schist, are of precambrian age. The detritus from the erosion of these rocks accumulated and dammed the river that flowed through the region, thus forming a lake about 1.5 km. across. Subsequent growth of vegetation resulted in a thick layer of peat at the bottom of this lake. The lake was then drained by the erosive action of the present stream (the Pulantien river) and the ancient peat bed, from one third to two thirds of a meter in thickness, is now left high and dry, some thirteen meters above the present level of the channel bottom. In the meantime, wind-blown dust from the Gobi Desert was deposited on top of the peat, which is now covered with loess to a depth of from half a meter to a meter and a half. The present stream has cut through the old lake bed and the river bluffs now expose a section of the ancient peat layer and the superimposed loess.

The old lotus fruits here considered are found in the upper portion of the ancient peat layer. They were doubtless produced by plants that flourished in the prehistoric lake. No evidence is at hand to indicate precisely how long ago the lake became dry, but from the depth of the present stream channel below the peat level and from the thickness of the loess layer it is estimated that the lake was drained at least three or four hundred years ago. It is therefore evident that the ancient fruits are probably at least three or four hundred years old.

(1) OHGA, I., Vegetation of Kwantung Leased Territory, p. 35. South Manchuria Railway Co., Dairen, August, 1923.

(2) OHGA, I., On the Longevity of Fruits of *Nelumbo nucifera*. (Bot. Mag. Tôkyô, **37**, 1923, 87-95.)

(3) MURAKAMI, B., Geology of Kwantung Leased Territory. South Manchuria Railway Co. Dairen, May, 1915.

The Unique Germination of the Ancient Fruits and Evidence of Their Extreme Longevity

More than two hundred of these ancient fruits have been tested for viability and all have germinated when submerged excepting a few that were not properly treated. There is no question as to their general viability, with a very high percentage of germination. But germination apparently does not occur, even when the fruits are submerged in water, unless a certain amount of the fruit coat is first removed (as by grinding or by sufficiently prolonged treatment with concentrated sulfuric acid) or unless the coat is mechanically broken or punctured. Fruits submerged without some such preliminary treatment have been allowed to remain under water for more than twenty months and have failed to germinate or even to show swelling. The untreated fruit coat shows itself completely or almost completely impervious to water.

Impermeability to water is also a striking characteristic of coats of present-day fruits of the Indian lotus, with which Japanese and Chinese gardeners are well acquainted. The plant is generally propagated by rhizomes, but when fruits are to be germinated the coats are always first filed and broken. It seems to be clear that one of the reasons, probably the main reason, why the ancient embryos here considered did not long ago germinate and subsequently die, lies in the fact that they are naturally so well protected against the inward penetration of water.

During the several hundred years of their sojourn in the continuously wet peat bed, the fruits have not at any time absorbed enough water to induce germination. They must have been exposed to water for years after their production, before the draining of the ancient lake, and they must have been subjected to the action of moist peat for long periods since standing water retreated from their habitat.

The retention of viability for such a long time under these conditions is probably due in large part to the approximate maintenance of the water and gas content in the tissues of the embryo. The coats of these fruits operate of course to prevent water loss as well as to prevent water entrance. The surrounding peat has doubtless acted to maintain rather uniform moisture conditions around the fruits and the water content of the latter has probably remained practically unchanged ever since the fruits ripened and fell to the bottom of the ancient lake. Furthermore, the long-buried fruits must have been protected from very rapid changes of temperature and this protective feature of their surroundings was

probably improved gradually as the loess layer became thicker above the peat.

Great longevity has been several times reported for fruits of the Indian lotus. BECQUEREL⁽¹⁾ reports the germination of lotus fruits that were as much as fifty-six years old. EWART⁽²⁾ classified these fruits as "macrobiotic" (long-lived). It appears that ROBERT BROWN observed the germination of lotus fruits that were more than one hundred and fifty years old, but the present writer has not been able to locate any published statement about this by BROWN himself. C. DE CANDOLLE⁽³⁾ reports the BROWN experiment as follows: "In 1850 ROBERT BROWN, out of curiosity, sowed some seeds from the collection of Sir HANS SLOANE, of which they had formed a part for more than a hundred and fifty years. He succeeded in making several of them germinate, particularly a seed of *Nelumbium speciosum*. The plant has been preserved in the galleries of the British Museum, where I saw it a few years ago."

It has been pointed out repeatedly that some kinds of seeds may⁽⁴⁾ retain their vitality for long periods when buried in the soil, seeds with seed-coats or pericarps that are only very slowly permeable to water and dissolved substances (notably oxygen) seem generally to live longer under these conditions than the seeds that can absorb water and solutes more rapidly.⁽⁵⁾

The embryos and endosperms of mature seeds generally contain but little water, and the vital processes (such as respiration) that naturally

(1) BECQUEREL, P., Recherches sur la vie latente des graines. (Ann. Sci. Nat. Bot., IX, 5: 193-320, 1907.)

(2) EWART, A. J., On the Longevity of Seeds. (Proc. Roy. Soc. Victoria, 1908, 1-120.)

(3) DE CANDOLLE, C., The Latent Vitality of Seeds. (Pop. Sci. Monthly, **51**, 1897, 106-111.)

(4) PETER, A., Culturversuche mit "ruhenden Samen." (Nachr. Koenigl. Ges. Wiss. Georg-Univ. zu Göttingen. **17**, 1893, 673-691; *ibid* **18**, 1894, 373-393).

EWART, W. J. See Foot-note 2 of this page.

BEAL, W. J., The Vitality of Seeds buried in the Soil. (Bot. Gaz., **40**, 1905, 140-143.)

DARLINGTON, H. T., Doctor W. BEAL's Seed Viability Experiment. (Amer. Journ. Bot., **9**, 1922, 266-269.)

DUEL, J. W. T., Vitality and Germination of Seeds. (U. S. Dept. Agr. Bur. Plant Ind. Bull. **58**, 1904, 96.)

DUEL, J. W. T., Vitality of Buried Seeds. (U. S. Dept. Agr. Bur. Pl. Ind. Bull. **83**, 1905, 20.)

GROSS, W. L., The Vitality of Buried Seeds. (Journ. Agr. Res., **29**, 1924, 349-362.)

(5) SHULL, C. A., Semipermeability of the Seed Coats. (Bot. Gaz., **56**, 1913, 169-170.)

lead to germination or to the ultimate loss of vitality are very slow indeed as long as the water content of the tissues remains very low. Consequently, seeds into which water can penetrate only very slowly are apt to retain vitality for a long time. Besides the entrance of much water into embryo and endosperm from without most seeds require the entrance of a considerable amount of oxygen also if germination is to occur, and seed-coats or pericarps that are nearly impermeable to water are generally also impervious, or nearly so, to oxygen. Impermeable coats are really characteristic of seeds that exhibit greatly delayed germination when kept buried in moist soil.⁽¹⁾

When germination is thus retarded vitality is longer retained if the soil temperature is relatively constant and comparatively low.⁽²⁾

Earlier References to the Fruits of *Nelumbo* and Related Forms

Two species of *Nelumbo* are recognized by CASPARY,⁽³⁾ *N. nucifera* and *N. lutea*. The former appears to be a native of south-eastern Asia, being now found in India, Persia, China, Japan, and Australia. It seems probable that the ancient Koreans, whose dominions extended over Mongolia about fifteen centuries ago, introduced the plant into the Orient, perhaps from Asia Minor.⁽⁴⁾ *N. lutea* is a native in central North America.

Mature plants from the ancient fruits here studied have not yet been secured and it is consequently impossible to identify the species exactly. The old fruits are of much smaller size than the recent fruits of *N. nucifera* now growing in China, Korea and Japan, and they seem to represent an earlier form of this species. It is hardly thinkable that they belong to the American species. Some structural comparisons between the ancient fruits and recent ones of *N. nucifera* will be considered below.

The developmental morphology of the *Nelumbo* fruit has been studied by many authors. WIGAND-DENNERT'S monograph⁽⁵⁾ and that of

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- (1) CROCKER, Wm., Mechanics of Dormancy of Seeds. Amer. Journ. Bot., **3**, 1916, 99-120.
 - (2) DETMER, W., Vergleichende Physiologie des Keimungsprocess. Jena, 1880, 269.
 - (3) CASPARY, R., Nymphaeaceae. (Engler und Prantl, Nat. Pflanzenfam., III. Teil, 2 Abt., 1891, 1-10.)
 - (4) Letter from Doctor Kyosuke UYEDA, Anthropologist and Secretary of the South Manchuria Railway Co.
 - (5) WIGAND-DENNERT, *Nelumbium speciosum* W., (Bibl. Bot., Heft 2, 1888, 120.)

WETTSTEIN⁽¹⁾ present the earlier literature. Further contributions have been made by WEBERBAUER,⁽²⁾ LYON,⁽³⁾ YORK,⁽⁴⁾ and COOK.⁽⁵⁾

Structural Features of the Ancient and Recent Fruits

Introductory.—The purpose of the present chapter is not to review the developmental history of these fruits, which has been recorded by the writers just mentioned and others, but it is rather to present comparative observations on the structural features of the ancient and recent fruits, with special reference to the resistance offered to the movement of water through the fruit coats and the manner in which prolonged treatment with concentrated sulfuric acid removes most of this resistance.

The *Nelumbo* fruit is a caryopsis. Before fertilization a single anatropous ovule hangs on its funiculus from the roof of the apocarpous ovary, the stylar canal connecting the superimposed style and stigma with the ovule through the funiculus. After fertilization the ovule enlarges and finally almost completely fills the ovarian cavity, the seed testa being closely applied to the inner surface of the pericarp wall excepting at the upper and lower ends, where the two surfaces are slightly separated.

External features (text-figs. 1 and 2).—Both the ancient and recent fruits are ellipsoidal, somewhat acute or pointed at the base, but the recent fruits are larger than the ancient ones. The sizes are indicated below.

	Ancient fruit	Recent fruit
Length of vertical axis (mm.)	15.0.....17	16.7.....18.8
Length of horizontal axis (mm.)	9.2.....10.5	10.7.....12.6
Average weight (gr.)	0.83	1.24

The color of the ancient fruit is dark brown, while that of the recent ones is lighter, grayish brown in general with the apical portion

(1) WETTSTEIN, R. VON, Beobachtung über den Bau und die Keimung des Samens von *Nelumbo nucifera*. (Verh. K. K. zool-bot. Gesell. Wien., **33**, 1888, 41-47.)

(2) WEBERBAUER, A., Beiträge zur Samen-anatomie der Nymphaeaceen. (Bot. Jahrb **18**, Heft 3, 1894.)

(3) LYON, H. L., Observations of the Embryogeny of *Nelumbo*. (Minnesota Bot. Studies, **2**, 1901, 643-655.)

(4) YORK, H. H., The Embryo-sac and Embryo of *Nelumbo*. (Ohio Nat. **4**, 1904, 167-176.)

(5) COOK, M. T., Notes on the Embryology of the Nymphaeaceae. (Bot. Gaz., **43**, 1911, 56-59.)

light brown and the external surface is glossy in the first case and dull and waxy in the second, the lack of luster in the ancient fruit is due to the almost complete lack of epidermis. The epidermal layer is still



Fig. 1.



Fig. 2.

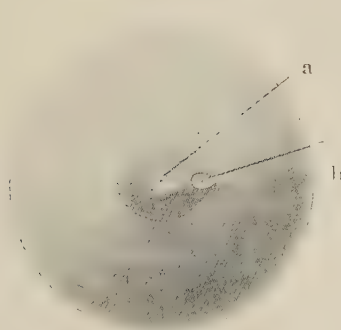


Fig. 1A

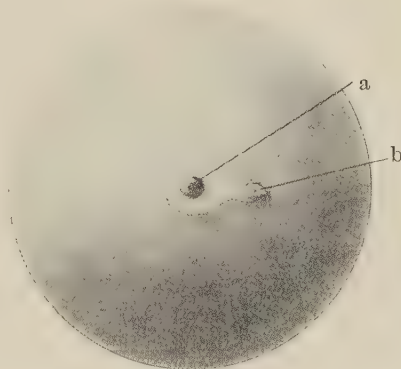


Fig. 2A

Fig. 1. Side view of an ancient fruit.

„ 1A. Top view of the same. At the center the styler depression (a) is seen surrounded by a dark ring; oval protuberance (b) by the side of the depression.

Fig. 2. Side view of a new (1 yr. old) fruit.

„ 2A. View of the same from above. At the center the remains of style surrounded by light brown coat. Protuberance as in Fig. 1A.

present in the other case. With the exception of the apical portion, the surface of the ancient fruit is seen to be dotted with tiny pits that represent substomatal cavities, but pits are not visible on the recent fruits. A remnant of the base of the style is generally present at the apical end of the recent fruit but this is never shown by ancient fruits. The location of the style remnant is marked in all ancient fruits by a slight depression in the surface. About a millimeter from the apical end in both forms there is located an oval raised area, which we will call the protuberance, in the center of which is a very small depression. At the basal end of the fruit there is a depression, where the fruit was connected to the receptacle by a short stalk, the withered remains of which is often found in situation in recent fruits. In the ancient fruit the edge of this depression is smooth, but in the recent one it makes a ridge.

General internal features (fig. 1).—The fruit wall is hard in both fruits but in the ancient form it is brittle while in the other it is horny. The seed completely fills the cavity of the fruit in both forms, excepting at the apical and basal ends, where contact between testa and fruit wall is not so intimate. A small cavity occurs between seed and wall of the fruit at the apex of the seed and the inner surface of the fruit wall shows a dark-colored, small, circular area at the very apex opposite to the stylar depression or the stylar remnant. The remainder of the inner surface of the fruit wall about the apical cavity is light brown in color. The basal cavity, which lies inside the fruit wall opposite to the external basal depression, is nearly filled by a local bulge or swelling of the seed. The inner surface of the fruit wall bordering this basal cavity is pale reddish brown in the ancient fruit and more deeply colored in the recent. The basal swelling of the seed is bordered by a shallow annular depression. The outer surface of the seed which lies next the apical and basal cavities is reddish brown. Throughout the remainder of its extent the seed testa is firmly adherent to the fruit wall. Most of the seed coat is very thin but it is very thick over the surface of concave spherical body in its top. Inside of the thin reddish brown skin, are two large white cotyledons which are in close contact. In the cross section through the middle portion of seed there is a quite large elliptical cavity in which a green plumule is located. From both corners of this cavity a fine line, the boundary of the cotyledon, runs to the periphery. Close to the funicle there is a very small pit indicating the position of the micropyle of the ovule. From this pit a small canal, about 2 mm. in length runs inward to the cotyledons. At the

bottom of this narrow canal a small radicle, about $\frac{1}{2}$ mm. in length, is located. In the large cavity between two cotyledons there is a green, well developed plumule, which consists of two young leaves, one much larger and longer than the other, and of a stem growing point between them. The plumule is slightly brownish green in ancient fruits but that of recent fruits is bright green.

Microscopic Features of the Coat of the Old Fruit

I. Pericarp.—The fruit coat is made up of three layers, namely, (a) the outer palisade layer, (b) middle sclerenchymatous layer, and (c) inner parenchymatous layer.

(a) *Palisade layer* (figs. 2, 3, 4).—The epidermis has entirely disappeared from all buried fruits. The outer surface is now made up of the outer ends of a layer of long and narrow prismatic cells. These, which have been termed Malphigian cells, prism cells, palisade cells or Hartschicht are in close contact with each other laterally. There are numerous small canals (fig. 2, k), numbering from 16 to 25 per sq. mm. over the entire surface of all fruit except in the vicinity of the apical end (fig. 5, h). These canals are believed to have extended to the stomata in the former epidermis as they are seen to do in new fruits. The orifice of each of these canals is funnel-shaped (fig. 2, l). The height of the palisade cell ($0.315 \frac{1}{\text{mm.}}$) is about nine times its width ($0.035 \frac{1}{\text{mm.}}$). The outer end of the cell is truncate but becomes narrow, conical, or acute towards the inner end. The outer wall of this cell is very thin but all the other walls are thick (fig. 3). The cell contents are colorless and nearly transparent, but with minute granules. Under the low power objective two distinct dark lines seem to run transversely at about the middle part of this cell and the space between these two lines refracts the light (fig. 3, c). The light refracting zone is termed the “hyaline zone,” “hyaline line” or “light line” (fig. 2, m; 3, e). Under a high power this zone is seen to consist of many radial pits (fig. 3, d), 8 or 10 in number as seen in cross section of the cell. The outer end of each of these pits is swollen a little according to WIGAND-DENNERT, this portion of the hyaline zone when developing was very densely filled with protoplasm.

The hyaline line curves outward at the stomatal canals (fig. 2, m) and the canals become slightly narrower and inwardly from this region the canals become wider. In this region the stomatal canals are of two forms, one almost closed and the other more open.

When a comparison is made between new and old fruits, it is found the relations between the hyaline zone and the palisade cells in the new fruits are not exactly the same in the ancient fruit. It seems clear that in case of the ancient fruits some external forces must have worn off some of the outer coat at all those points.

(b) *Sclerenchymatous layer* (fig. 2, c). This layer located within the palisade cells is 10 or 12 cells thick and has a total thickness of 0.7 mm. The outer cells of this layer are radially elongated and large but the cells become small and round farther inward. The cell walls are thick and pitted. This layer is attached immediately to the palisade layer without but farther inward there are abundant intercellular spaces. These intercellular spaces radiate from points opposite the inner ends of the stomatal canals.

(c) *Parenchymatous layer* (figs. 2 d, 7 and 8). The layer is next within the sclerenchymatous layer. The cells in this layer are irregular in shape and the cell walls are thin. Intercellular spaces are abundant and large, vascular bundles also are found running through this layer. In general, the cells are colorless and transparent but there are some cells of a brown color. The latter are large in size and are generally found in the innermost part (Fig. 8).

II. Seed Coat Testa (fig. 2).—The seed coat is made up of three layers, which will be designated as (a) outer, (b) middle, and (c) inner.

(a) *Outer layer* (fig. 9).—The outer layer is two cells deep and consists of parenchymatous cells of smaller diameter. The cell walls are thin and the cells are in very close contact. Stomata are very seldom seen in the outer layer. This layer evidently is a semipermeable membrane.

(b) *Middle layer*.—This layer resembles the parenchymatous layer of the pericarp. In it are large intercellular spaces. Three rows of vascular bundles enter it ventrally, but there are not on dorsal side.

(c) *Inner layer*. This is an irregular thin layer and has many intercellular spaces. It seems to contain the remain of the endosperm of seed. This layer is attached to the cotyledons and aleuron grains are found in their outermost cells (fig. 2, i). In there is parenchymatous layer with small starch grains (fig. 2 j).

III. Special Structure of the Palisade Layer of the Fruit Coat.—There are three specialized areas in the hard fruit coat, (a) at the stylar tip; (b) at the protuberance; and (c) at the basal end.

(a) *At the Styler Tip* (Fig. 5 a).—A styler canal runs inward from the styler scar and enters directly into the fruit cavity from the center of the elevation of the apical depression. The walls of this canal are composed of thick sclerenchymatous cells. The canal is filled by protuberances from its wall cells or with particles of organic material. On the outer surface of this area there are no stomatal canals and the palisade cells are much divided by periclinal walls. Passing inwards these palisade cells grade gradually into sclerenchymatous cells. Some vascular bundles terminate in these tissue cells.

(b) *At the Protuberance* (figs. 2 b, 5).—There is a special organ in the region of the protuberance. It is divided into two parts, the inner and the outer which are connected by a narrow neck (fig. 5 k, l). In each part there is a large cavity which arises as an intercellular space (fig. 7 c). The outer cavity, ovoid in shape, is covered on the outside with palisade cells which are without stomatal canals and are enveloped by the sclerenchymatous layer of fruit coat. The inner portion of the cavity is surrounded by the sclerenchyme layer and has the form of a truncated funnel. The innermost wall of this cavity is parallel to the inner wall of the fruit and five or six layers of sclereids fill the space between them.

The wall of the outer cavity is composed of compact colorless, thick-walled, spherical and elongated cells. The spherical cells are found chiefly near the inner wall, though some are isolated and scattered. The cell cavity of the elongate cells is small and the cells themselves appear much like palisade cells, but the ends of these cells are not truncated, they are acute. Around this cell layer is the sclerenchymatous of the fruit. At the inner and lower portion of the outer cavity there is a mass of parenchymatous cells; the great majority of the vascular bundles of the fruit terminate in this tissue. (figs. 5 j, 10 a). Each of these parenchymatous cells has many pits of varying size which communicate with the inside and outside of the cell (fig. 10 d). Sphaerocrystals of calcium oxalate are found in numbers of cells in the free edge of this tissue, and there are also a few isolated crystal-bearing cells attached to the wall of the cavity. Cells containing sphaerocrystals are also found in the inner half of the cavity. The presence of tannin in these sclerenchymatous cells gives a dark brown color to this layer. The thick walled cells surrounding the outer cavity when tested with phloroglucin and hydrochloric acid take on a bright pink color, thus demonstrating the lignification of those cell walls.

(c) *At the Basal end.* At this end of the fruit the palisade layer curves inward. The vascular bundles also curve in at the center of it and are attached very closely to the palisade cells. The reaction to phloroglucin and hydrochloric acid shows that lignification had taken place in these palisade cells also. The sclerenchyma cells inside of the palisade cells at this region are colorless and the cell contents less abundant. In shape these cells resemble those which are found around the outer half of the cavity beneath the protuberance.

Microchemical Nature of the Cell Wall

In order to ascertain whether there is any chemical difference between the cell wall in the fruit and seed coat of ancient and recent fruits, a series of microchemical tests were undertaken. The reaction of palisade cells in both old and new fruits to chlor-iodide of zinc was violet. Furthermore, their cell walls are soluble in concentrated sulfuric acid which shows that the cell wall consists of cellulose. However, in the case of the ancient fruit the outer edge of the hyaline zone took a deeper stain than the inner edge. When the hyaline zone is treated by chlorzinc-iodide or concentrated sulfuric acid, the pore canal expands and the region becomes dark. Alcoholic solution of safranin also gave the same result. Usually the hyaline zone takes less stain than the rest of the cell but when Congo red or haematoxylin is used the cell wall is stained evenly and equally throughout its length.

When the cell wall of the palisade cells is treated with concentrated sulfuric acid, the contents of the cells do not dissolve for a long time, so that they have a curious appearance long after treatment with the acid. Though the nature or structure of this zone which refracts the light could not be determined, it seems that the anisotropic nature of the hyaline zone is due to abundance of the cell contents in the locality, and the refractiveness of the cell wall on both sides of hyaline zone must be due to the presence of pits in this part of the wall. The cell walls of the sclerenchymatous cells also show the reaction for cellulose and the cell contents includes tannin. In the aqueous solution of ferrous chloride they turn blue. The parenchymatous cells of the fruit coat and of the entire seed also show the reaction for cellulose and some of them also contain tannin.

Thus practically all the fruit coat shows the cellulose reaction with the exception of certain cells in the vicinity of the styler canal at the stigmatic end, those of the area where the bundles enter the fruit, also

the colorless thick cell walls of the inner wall of outer cavity at the protuberance and the fibrovascular bundles. The inner walls of the outer cavity at the protuberance, furthermore, shows a reaction to Sudan III indicating suberin. This particular reaction for cork was not seen in the recent fruits.

If a comparison between ancient and recent fruit is made, the ancient fruit shows evidence of corky walls in cells at the protuberance. The outer cell wall of the palisade cell stained with safranin and Sudan III which at once threw doubt upon the presence of an actual cuticle on epidermal cells of the recent fruit.

The Entrance of Water into the Fruit

In order that the fruit or seed may germinate it is necessary for water to penetrate from the outside. The only possible water passages in the hard coat of a *Nelumbo* fruit are: (a) the stylar canal, (b) the basal depression, (c) the stomatal canals, and (d) the protuberance.

(a) *Stylar canal*. This is the remains of a small canal in the sclerenchymatous layer at stylar apex through which the pollen grains pass. This remains filled with projections of the cell walls of the canal and organic materials, so that it is difficult to distinguish one from the other. The canal is rather long and near its opening to the outside it is bordered by palisade cells whose lateral walls come very close together and leave no intercellular space, and since the cell wall is lignified it would be rather difficult for water to go through this canal.

(b) *The basal end*. The receptacle where the fibrovascular bundle is connected is filled with thyloses. The cell walls of the palisade cells are very thick and lignified in this region and their contact is very close, there being no intercellular spaces. This prevents the penetration of water through this portion of the fruit.

(c) *Stomatal canals*. The canals through which transpiration took place became narrow as the drying of fruit went on and apparently almost stopped transpiration of water vapor from the fruit. This is also shown by the fact that the inner cavity of the fruit is filled with air and even boiling did not drive the air out of the cavity. In order to ascertain how and where water penetrates into the inside, a number of attempts were made to soften the hard coat with acids, alkalies, and alcohols. While 50% chromic acid, concentrated nitric acid, and 75% potassium hydrate acted very slowly, concentrated sulfuric acid alone was able to penetrate the hard coat after a time. Therefore concentrated

sulfuric acid was used in the following experiments. The *Nelumbo* fruits were immersed in the acid and at intervals of an hour some were taken out of it. After being thoroughly washed with tap water, they were transferred to tap water for germination and a series made according to the length of time of immersion. The shortest period they were allowed to remain in acid was fifteen minutes and the longest was eight hours. The table shows the period of immersion in acid until the first indication of swelling.

Period of soaking in concentrated H_2SO_4	Subsequent soaking in H_2O before swelling became evident.
<i>Hours</i>	<i>Days</i>
1.0	23
1.5	8
2.0	3
2.5	1.5
3.0	1.0
4.0	0.2
5.0	1 hr.

Those which remained in acid less than an hour did not show any sign of swelling at the time this table was made, whereas those left in the acid over an hour finally swelled and germinated. The longer they had remained in the acid, the quicker they began to swell. It was almost impossible to determine the exact beginning of the swelling in those remaining in acid any more than six hours.

A microscopical examination of the palisade cells treated with concentrated sulfuric acid revealed the fact that the acid first acted on the external opening of the stomatal canal and then gradually extended on each side as is shown by text-figures 3, 1-6. At the end of one hour the acid had reached the hyaline zone, and during this period the outer end of the canal is enlarged by the acid and becomes funnel-shaped. The stomatal canal becomes widened by the action of the acid beyond the hyaline zone. The water from outside then gets a free access through the newly widened canal which was too narrow for penetration before. Some other palisade cells on the outer coat were not affected by the acid at this time. They remained intact and formed elevated areas plateau in the coat. Sudan III or safranin stains the surface of these areas. It seems that a cuticle which resists the acid is present on the outer surface of these palisade cells and actually prevents the solvent action of concentrated sulfuric acid on the cellular walls beneath.

The action of the acid goes on continuously as the time passes and

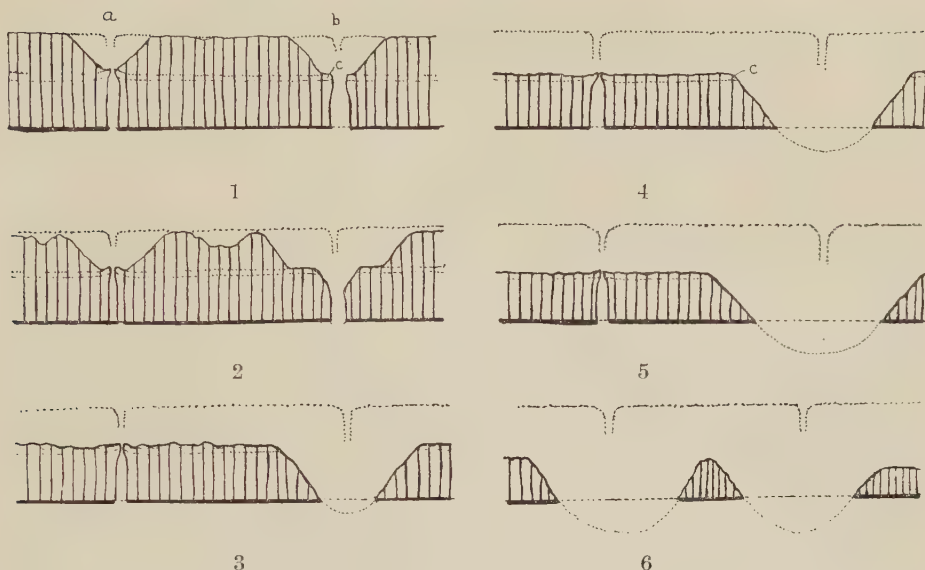


Fig. 3. Diagram of palisade cell layers affected by concentrated H_2SO_4 for period of 1, 2, 3, 4, 5 and 6 hours as numbered. There are two types of stomatal canals; one closed (a) and the other opened (b). The concentrated H_2SO_4 reaches to the hyaline zone (c) in 3 hours and passes through the zone in 6 hours.

the funnel shaped stomatal canal becomes larger and deeper, consequently the palisade plateau becomes smaller. About three hours later the solvent action of the acid has advanced to the hyaline zone, when the acid comes to this level its advancement is checked. Other areas than those near the stomatal canal become almost level. At the stomatal regions, however, there are two different appearances. The one is funnel-shaped and the other is a number of small uneven protuberances along the hyaline zone. The former is of course the result of the action of the acid on the cell wall substance near the stomatal canal and the latter is made by the action of the acid where it is checked at the hyaline zone. So there are two types of stomatal canal; the one type is an open canal and the other is a closed one. In the course of the action of sulfuric acid gradually the funnel-shaped canal becomes wider and deeper, and finally it reaches to the sclerenchymatous layer. From about four hours and a half most of the area of the hyaline zone begins to give way to the action of the acid and two hours later it has disappeared completely. The funnel-shaped canal becomes still larger and the regions about the closed canals, as long as their basal point are not eaten by the acid,

remain standing between the funnels, like pyramids. They, however, are finally dissolved by the acid and seven hours after the beginning of exposure to the acid practically all the palisade cells are destroyed and the fruit coat has been dissolved down to the level of the sclerenchymatous layer. When it comes to this point the penetration of the water can occur very quickly, usually in less than ten minutes.

Thus from the mouth of the stomatal canal, where the acid began its action against the fruit coat it takes about one hour for it to reach the hyaline zone where its further advance is retarded by a special structure of the wall which can resist the action of the acid to a considerable degree. As long as the acid does not reach to the hyaline zone the water is hardly absorbed at all by the fruit, but once this hyaline zone is removed by it the water can go in very freely.

Over most of the fruit the acid does not reach to the hyaline zone in less than an hour as has been shown. At the basal end and stylar tip of the fruit, however, on account of the thin palisade cells of these areas, the acid reaches to the hyaline zone in less than an hour. The cells at these points were rubbed off by natural processes and had become thinner than on other parts. In such cases the fruits treated with acid for even less than an hour will swell up after some time. Water then seems to get into the fruit only through the stomatal canals and the hyaline zone prevents the entrance; consequently this zone has a great deal to do with the long persistent dormancy of these fruits.

(d) *Protuberance*. On the protuberance the palisade cells are truncated at both ends, and between this layer and the next there is a space, which extends beneath the entire circumference of protuberance. This gap opens to the large external cavity of which a detailed description is given in the early part of this paper. And in this cavity there is a mass of parenchymatous cells which seem to serve as an absorbing tissue. The limits of the hyaline zone of this region are not very clear. If water can pass through the fruit coat this tissue would seem to be in the most suitable place for absorbing water since the position of this tissue is very close to the radicle of the embryo. But in the recent fruit as there are no calcium oxalate crystals deposited in the epidermis at the protuberance and no stomata in the same locality, it is evident that there has been very little water loss, if any. Dehydration by means of absolute alcohol or a dessicator was not capable of drawing the water vapor from the cavity, neither method caused any change in the parenchymatous cell mass. A number of fruits in which the palisade cells at

the protuberance are already broken without artificial means were selected and they were placed in water for two years yet there was no sign of swelling.

Conclusion

The longevity of the fruits of *Nelumbo* seems due to the fact that besides being buried in the peat they are covered with a hard coat formed of the palisade cells. There are twelve families which have palisade cells in the fruit- or seed-coats and among those having macrobiotic seeds, according to EWART,⁽¹⁾ many have palisade cells. A palisade layer is found in the fruit or seed coat of many Leguminosae, Malvaceae, and Nymphaeaceae, and occurs also in the sporocarps of the Marsiliaceae. The relation of cuticle and palisade cells of the hard seed to the longevity of the fruit has been discussed elsewhere by many authors.⁽²⁾

They have published the results of their studies on the hyaline zone of palisade cells of various seeds and fruits. Since they worked with different materials, the results of their investigations with reference to the structure, reaction to chemical tests and their conclusions are not exactly the same, even though they are quite agreed in above mentioned facts.

It is a common practice these days to use concentrated sulphuric

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(2) RUSSOW, E., Vergleichende Untersuchungen betreffend d. Histologie vegetativen Sporen bildenden Organe in d. Entwicklung d. Sporen d. Leitbündel-Kryptogamen mit Berücksichtigung d. Histologie d. Phanerogamen ausgehend von der Betrachtung d. Marsiliaceen. (Mém. Acad. Sci. St. Pétersbourg, VII, 19: 281, 1873.)

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PFAEFFLIN, P., Untersuchungen über Entwicklung, Bau und Funktionen der Nabelspalte u. s. w. praktisch wichtigen Papilionaceensamen. (Inaug. Diss. Berlin, 1-35, 1897.)

JOHNSON, D. S., On the leaf and sporocarp of *Plularia*. (Bot. Gaz., 26, 1-24, 1898.)

PAMMEL, L. H., Anatomical characters of the seeds of Leguminosae, chiefly genera of Gray's Manual. (Diss. Wash. Univ. 1-274, 1899.)

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ZARYMOWSKI, A., Über die Hartschaligkeit von Leguminosensamen und ihre Beseitigung. (Diss. Halle, 1-30, 1905.)

acid for the germination of hard seeds⁽¹⁾ but the seeds are not treated in acid any longer than a few minutes; whereas in case of old *Nelumbo* fruit it can stand the treatment as long as twenty four hours without being killed.

The outstanding factors for the longevity of *Nelumbo* fruits are the burial in the soil for centuries and the characteristic structure of the palisade cells which can resist the action of strong acid for many hours.

Summary

1. The ancient fruits which were found in the peat at Pulantien basin, South Manchuria and recent fruits of *Nelumbo* differ in shape, size, color, luster and texture.

2. The ancient fruit has lost its epidermis and thick-walled palisade cells become exposed.

3. There are stomatal canals among the palisade cells, each of which lies below a stoma. There are no stomatal canals or stomata at the stigmatic end.

4. The wall of palisade cell is of cellulose but its thin outer layer gives the reaction for cuticle when tested with Sudan III, or safranin and chlorophyll solution.

5. The hyaline zone which runs crosswise in the middle part of each palisade cell bends upward nearer to the outer surface in the cells near each stomatal canal.

6. The appearance of this hyaline zone is due to the presence of radiating pits from the central cavity of each palisade cell and these pits appear as slits when seen in a tangential section of the cell.

7. In the protuberance at the stylar end of the fruit there is a special cavity of schizogenous formation. Fibrovascular bundles terminate near it. An abundant deposit of calcium oxalate crystals is evident in cells nearest the cavity.

8. Both at the stigmatic end and at the basal end of the buried fruits the palisade cells were frequently found to have been worn off by natural processes and the hyaline zone also broken.

9. The stomatal canal and hyaline zones are important factors in

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WHITE, J., The occurrence of an impermeable cuticle on the exterior of certain seeds. (Proc. Roy. Soc. Victoria, **21**, 1908, 203-210.)

ZARZYMSKI, A., l. c.

controlling the passage of water. Unless the fruit coat is removed or broken by some mechanical or chemical treatment there seems to be no way for the water to get into the fruit.

10. Concentrated sulfuric acid, 50% chromic acid, concentrated nitric acid and concentrated potassium hydrate can dissolve the palisade cells, but sulfuric acid is the most satisfactory solvent.

11. There is a definite relation between the time that concentrated sulfuric acid is allowed to carbonify the fruit coat and the time required for the swelling of the fruit. The time required for the beginning of swelling is inversely proportional to the time of immersion in acid.

12. Even though the fruit was treated 24 hours with concentrated sulfuric acid, the embryo within was not killed.

13. The cause of the longevity of the fruit of *Nelumbo* is due to its being buried in the soil and being covered with a hard coat, impermeable to water.

April, 1925. EDUCATIONAL COLLEGE, DAIREN, MANCHURIA.

Explanation of Plate I

- Fig. 1. Diagrammatic sketch of a longitudinal section of a fruit. (a) stylar end; (b) special organ beneath protuberance; (c) basal end (fibrovascular bundles enter at this point into the fruit); (d) cavity of fruit at basal end; (e) cavity of fruit at the stigmatic end (the stylar canal and both cavities of fruit are separated in the sketch to show the structure); (f) funiculus and remains of micropyle (fibrovascular bundles of seed coat enter at this place); (g) cotyledon; (h) radicle; (i) plumule, with first and second leaves well developed, in the cavity between the cotyledons.
- Fig. 2. Cross section of the hard coat. (a) epidermis (in the ancient buried fruit this is not to be seen); (b) palisade layer; (c) sclerotic layer; (d) parenchymatous layer (through which fibrovascular bundles run); (e) innermost layer of fruit coat; (f) outermost layers of seed coat; (g) parenchymatous layer of seed coat (through which fibrovascular bundles run); (h) irregular structure; (i) aleuron layer of cotyledon; (j) storage tissue of cotyledon; (k) stomatal canal; (l) a space between the orifice of canal and the epidermis; (m) hyaline zone; (n) schizogenous air cavity.
- Fig. 3. Side view of palisade cells. (a) cell wall; (b) central canal; (c) hyaline zone; (d) slit-like pit; (e) another pit.
- Fig. 4. (a) Cross section of upper or lower part of palisade cells; (b) the same, another view; (c) a transverse section at level of hyaline zone, where the pits in wall radiate from the central canal or cell cavity.
- Fig. 5. Diagrammatic sketch of apical end. (a) stylar tip; (b) protuberance; (c) special organ beneath protuberance; (d) stylar canal; (e) fruit cavity; (f) micropylar remains; (g) many-layered epidermis; (h) palisade cell layer; (i) the same at

the stigmatic top (broken line indicates where the hard coat has been worn away in old fruits); (j) end of fibrovascular bundles; (k) outer cavity of special organ; (l) inner cavity of the same; (m) air cavity; (n) mass of crystal cells; (o) colorless sclereid; (p) parenchymatous mass of pitted cells.

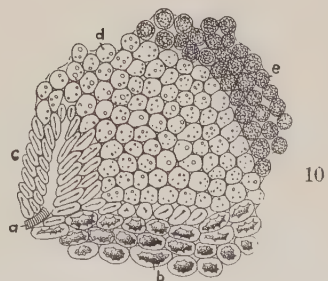
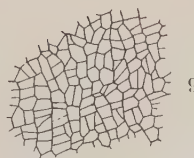
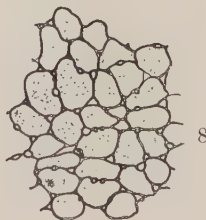
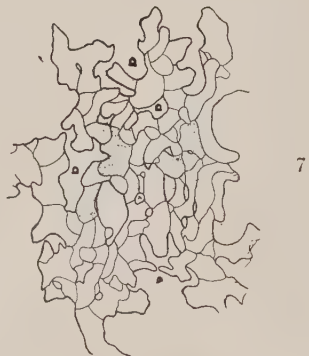
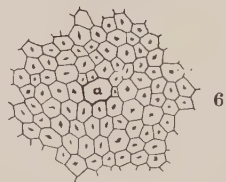
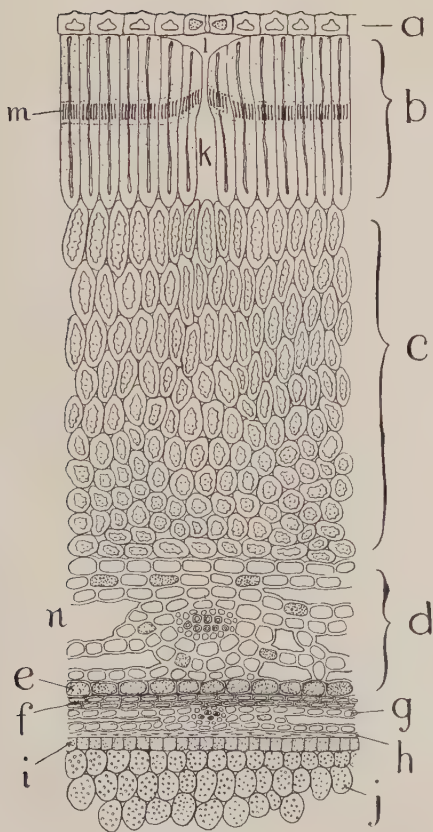
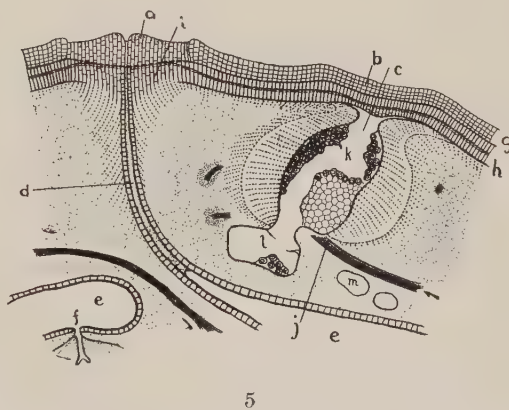
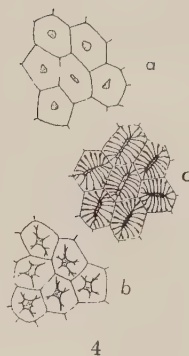
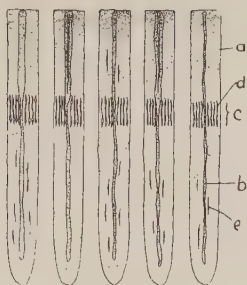
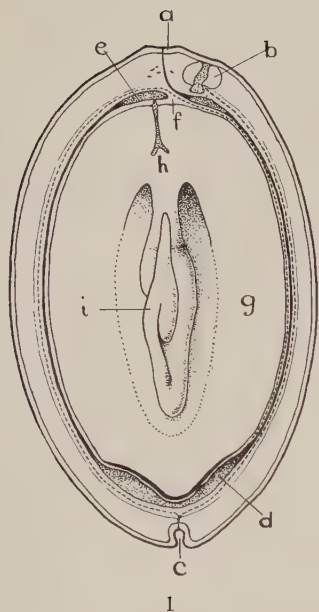
Fig. 6. View of palisade cells from outer surface; (a) orifice of stomatal canal.

Fig. 7. Tangential section of parenchymatous cells of fruit coat, with intercellular spaces *a*.

Fig. 8. Tangential section of innermost cell layer of fruit coat.

Fig. 9. Tangential section of the outermost layer of seed coat.

Fig. 10. A portion of tangential section of interior of special organ; (a) an end of fibrovascular bundle; (b) sclereids containing protoplasm; (c) colorless sclereids; (d) parenchymatous mass of pitted cells; (e) mass of crystal cells.



Über die Chromosomen von *Rumex scutatus*

Von KOI NODA

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(Hierzu 6 Textabbildungen)

(Eingegangen am 15. Juli 1925)

Die Chromosomen der *Rumex*-Arten wurden früher von einigen Autoren wie folgt als Vielfache von 8 festgestellt:⁽¹⁾

Haploid.

Untergattung <i>Acetosa</i> .	<i>Rumex acetosa</i> .	8	} ROTH (1906)
	„ <i>arifolius</i> .	8	
	„ <i>hispanicus</i> .	8	
	„ <i>nivalis</i> .	8	
	„ <i>scutatus</i> .	12	
	„ <i>acetosella</i> .	16	
Untergattung <i>Lapathum</i> .	<i>Rumex verticillatus</i> .	ca 24	FINK (1899)
	„ <i>crispus</i> .	32	DUDGEON (1918)
	„ <i>cordifolius</i> .	ca 40	ROTH (1906)

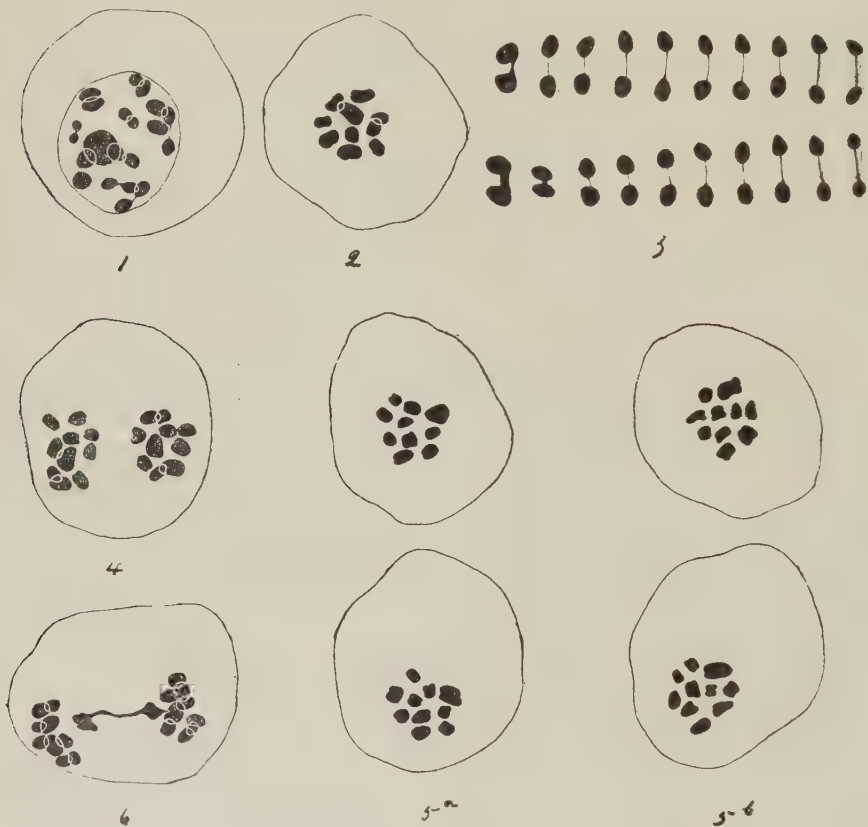
In den letzten Jahren, haben KIHARA und ONO (1923), SINOTÔ (1924) und MEURMAN (1925) die Geschlechtschromosomen bei den zweihäusigen Arten, nämlich bei *R. acetosa*, *R. thyrsiflorus* und *R. acetosella* gefunden. Durch diese auffallende Entdeckung ist die cytologische Untersuchung dieser Gattung von immer grösserer Bedeutung geworden. Die Resultate dieser Autoren sind folgende:

Autor	Species.	Chromosomen-Formeln.			
		männlich		weiblich	
		Diploid	Haploid	Diploid	Haploid
KIHARA u. ONO (1923)	<i>R. acetosa</i> .	12+x+y+y	6+x, 6+y+y	12+x+x	6+x
SINOTÔ (1924)	„	„	„ „		
MEURMAN (1925)	<i>R. thyrsiflorus</i>	12+x+y+y	6+x, 6+y+y	12+x+x	6+x
KIHARA (1924)	<i>R. acetosella</i>			42	
MEURMAN (1925)	„	38+x+x+y	19+y, 19+x+x	38+x+x+x+x	19+x+x

(1) Citirt nach KIHARA (1924).

Nach den oben gemachten Angaben möchte ich als sicher vermuten, dass die zweihäusigen Arten alle Geschlechtschromosomen haben.

Rumex scutatus ist eine trimonözische Pflanze mit weiblichen, männlichen und, selten, zweigeschlechtlichen Blüten. Sie gehört der Unterart *Acetosa*. Bei dieser Pflanze sind Geschlechtschromosomen vollständig ausgeschlossen, doch ist sie besonders dadurch interessant, dass sie unter den sonst zweihäusigen *Acetosa*-Arten die einzige trimonözische ist.



Sämtliche Bilder sind ungefähr 2500-fach vergrößert.

1. Diakinese.
2. Heterotypische Metaphase in der Polansicht.
3. Chromosomen aus den Garnituren in der späteren Metaphase.
- 4-5. Heterotypische Anaphase, zehn chromosomige Tochterplatten deutlich zu sehen.
6. Chromosomenbrücke in der heterotypischen Anaphase.

Das Material stammte aus dem Engadin. Beim Fixieren habe ich guten Erfolg mit dem CARNOYSchen Gemisch gehabt. Die FLEMMINGSche Lösung war ungeeignet.

In der Diakinese ist die Verbindung der homologen Chromosomen locker, das führt leicht zu einer Täuschung, nämlich zu einer Überschätzung der Zahl der Chromosomen. Wie ich in Fig. 1 zeige, konnte ich öfters 10 Gemini sicher zählen. Es gibt kein tripartites Chromosom bei *R. scutatus*, wie es bei *R. acetosa*, *R. thyrsiflorus* und *R. acetosella* gefunden worden ist.

Durch die genaueren Beobachtungen der metaphasischen Seitenansichten konnte ich sicher bestimmen, dass die homologen Chromosomen gleiche Form und gleiche Grösse haben, und auch die Zahl der Chromosomen beträgt in diesem Stadium 10. Die von ROTH (1906) festgestellte Chromosomenzahl 12 ist daher zu hoch.

Es ist bemerkenswert, dass eines von den 10 Chromosomenpaaren viel grösser ist als die anderen. Dieses Paar steht meistens an dem Rande der Kernplatte und teilt sich später als die anderen. Als extremer Fall findet man dabei eine Chromosomenbrücke in der heterotypischen Anaphase.

In der Anaphase stehen die Tochterchromosomen nicht dicht bei einander; deshalb ist es ein geeignetes Stadium für die Zählung. Ich habe in diesem Stadium viele homologe Tochterplatten untersucht, und ich konnte auch hier 10 Haploidchromosomen feststellen.

In der homöotypischen Kernteilung befinden sich auch 10 Chromosomen und wieder das grosse unter ihnen, welches ich bei den heterotypischen Kernteilungen bemerkt habe.

Bisher konnte ich leider die somatischen Chromosomen nicht untersuchen. Aber ich konnte alle homologen Chromosomen genügend auf ihre Grösse und Form prüfen. Es gibt keinen morphologischen Unterschied zwischen den homologen Chromosomen, d. h. wir konnten keine spezifischen Chromosomen finden. Die Untersuchung der Untergattung *Lapathum* muss ich mir zur Zeit noch vorbehalten.

Diese Untersuchungen wurden während eines kurzen Aufenthaltes im Kaiser Wilhelm Institut für Biologie, Berlin-Dahlem (im Sommer 1925) ausgeführt. Ich möchte Herrn Prof. C. CORRENS für die freundliche Überlassung des Materiales bei dieser Gelegenheit meinen herzlichsten Dank aussprechen. Besonderen Dank schulde ich Herrn Prof. H. KIHARA für die Stellung der Aufgabe und seine freundliche Unterstützung.

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Studies on the Mutations in *Oryza sativa* L.

I. On Staminoidal Sterile and Roll-Leaved Fertile Mutants

By **Isaburo NAGAI**

With 5 Text-figures

(Received July 6, 1924)

Introduction

In 1914 one of F_4 families of a cross between two types of paddy varieties "Isikawagaeri" and "Daikoku" (s. fig. 1, right, p. 26 and fig. 5, left, p. 37) was found to contain an entirely new form which had apparently arisen by mutation. The characters involved in the original cross and those of the new form are as follows:

Characters	♀ Isikawagaeri	♂ Daikoku	Mutants
Height of plant	normal	dwarf	normal and dwarf
Awn	full-awned	very short	completely awnless
Leaf	normal	normal	rolled
Fertility	fertile	fertile	completely sterile
Paleas	normal	normal	narrow

As shown above, the mutant is completely sterile and awnless. Its leaves are rolled at the base of the blade so that they are drooped downward instead of holding the upright position as in the normal case. Sterility is due to staminody: the feather-shaped stigma is transformed into three extra anthers which are mostly abortive but occasionally produce healthy pollen grains, hence this mutant is called *staminoidal sterile* (s. figs. 1-2). In this plant the fecundation is naturally impossible, and the mutant form can only be kept as a staminate stock. It has happened therefore that a dioecious form has arisen from the hermaphrodite *Oryza*.

The rollness of the leaf is due to a midrib so incompletely developed that we may say, practically the latter is not developed at all.

Three characters above mentioned, sterility (absence of stigma), awnlessness, and rollness of leaf (absence of midrib) are completely linked. This mutant form appeared as both normal and dwarf segregates, the latter character being recessive to the former. The family in which the mutants have been discovered was designated *SO*, and the mutant characters have been studied on the progeny of the normal stature.

In the next year another form of mutant has been discovered in one of the families which I will call *NK* and which is derived from a sister family of *SO*. In this case, the sterility and rollness of the leaf are not linked: the mutants are roll-leaved but awned and very slightly sterile, and the rollness of the leaf is



Fig. 1. Left, roll-leaved staminodal sterile mutant (*SO* family); right, "Isikawagaeri," normal type.

much less pronounced than in the staminoidal sterile; it is designated *roll-leaved fertile*. A peculiar feature of the latter mutant is that a certain number of spikelets produce more than one ovary, each of which has a fully developed stigma. Though the number of such abnormal extra ovaries varies from one to three (s. fig. 3), the mature spikelets contain only a single grain as in the normal case, hence it is evident that the extra ovules are not functional.

As already mentioned, the second of the above mentioned two mutant forms is generally completely fertile or very slightly sterile but

occasionally partially sterile to a marked degree. This type of sterility differs from that of the completely sterile mutant of the *SO* family, as in this case sterility is not necessarily linked with the abnormal structure of the floral organs.

In the next year (1917) a complete linkage of sterility and rollness of the leaf, as in the case of the



Fig. 2. Staminal sterile. Stigmas transformed into anthers.

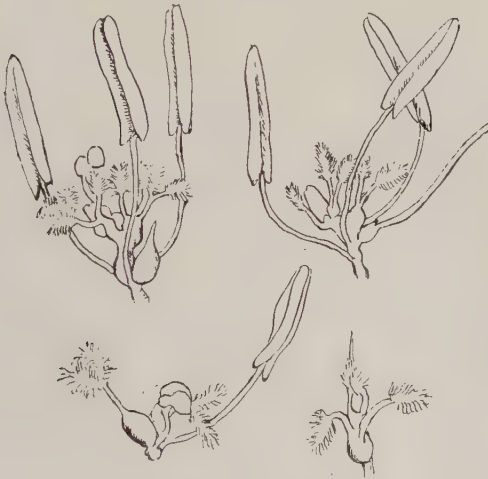


Fig. 3. Roll-leaved fertile. Supernumerary ovaries and stigmas.

staminoidal sterile mutants of *SO* has been discovered in one of the progenies of *NK* (designated *NO* family). In this case the rollness of the leaf is also very much pronounced, and the abnormality in the floral organ is essentially the same as in the staminoidal sterile of *SO* family. It can be seen therefore that the family *SO* has arisen by a single step, whereas *NO* did by two steps extending through two successive generations.

I. Staminal Sterile

This mutant appeared in one of 67 F_4 families (No. 26) as a recessive segregate, hence it is evident that its mother plant was heterozygous in respect to the factor of the mutant character. The family No. 26 was one of ten families derived from the long-awned normal-

leaved plant, and has undergone the segregation in respect to the awn and stature characters. Thus the mutants appeared both as the normal and dwarf plants, and as regards the awn, four classes could be distinguished (s. fig. 4), namely,

1. Class I, longest and many, designated "full-awned" (fig. 4, I),
2. Class II, shorter and fewer, "medium-awned" (fig. 4, II),
3. Class III, still shorter or even trace, and still fewer than in Class II, "rare-awned" (fig. 4, III),
4. Class S, completely awnless, "awnless" (fig. 4, S).

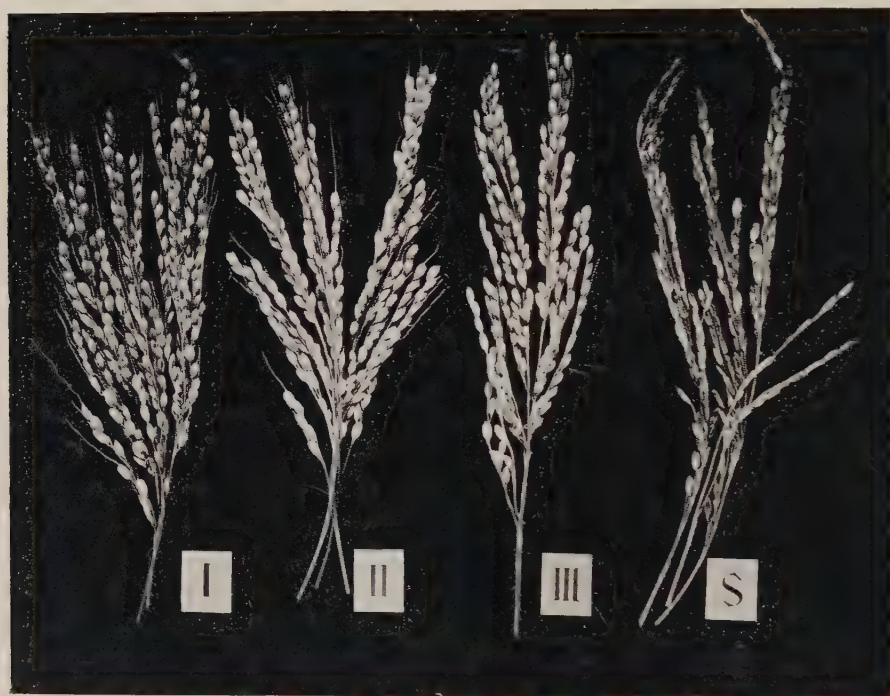


Fig. 4. Panicles showing the four classes of awn. I=Class I, full-awned; II=Class II, medium-awned; III=Class III, rare-awned; S=Class S, awnless. The first three are normal-leaved and the last one is roll-leaved and sterile.

The discrimination of the first two classes is somewhat difficult on account of the considerable modificability by the external conditions. The first three classes are found exclusively in the normal-leaved plants, while the awnless one is always roll-leaved. The observed numbers are as follows:

TABLE 1

	Full-awned	Medium-awned	Rare-awned	Awnless	Total
Normal-leaved	62	7	9	—	78
Roll-leaved	—	—	—	10	10
Total	62	7	9	10	88

Let N stand for the factor for the normal floral organ, leaf and awn, and its recessive allelomorph n for that of the mutant form, i. e., staminoidal sterile, awnless and roll-leaved. Further we suppose that the factor B be the modifier of the development of the awn and has no effect whatever without N . The simultaneous presence of N and B produces the awn of Class I, i. e., the plant is full-awned. Under the homozygous condition of N without B , i. e. $NNbb$, the awn belongs to the Class II, or is medium, and under the heterozygous condition of N without B , i. e. $Nnbb$, it belongs to Class III or is rare. The selfing of $NnBb$ plant will give the following offspring:

Type of families	Phenotypes	Genotypes	Ratio
Type I	fertile, normal-leaved, full-awned	$NNBB$	1
“ II	“ “ “ “ “	$NNBb$	2
“ III	“ “ “ “ “	$NnBB$	2
“ IV	“ “ “ “ “	$NnBb$	4
“ V	fertile, normal-leaved, medium-awned	$NNbb$	1
“ VI	“ “ “ rare-awned	$Nnbb$	2
“ VII	sterile, roll-leaved, awnless	$nnBB$	1
“ VIII	“ “ “ “	$nnBb$	2
“ IX	“ “ “ “	$nnbb$	1

These four kinds of phenotypes would give the 9:1:2:4 ratio. All the medium-awned plants should be constant, while rare-awned plants should be heterozygous segregating into three classes, i. e., medium, rare and awnless ones in 1:2:1 ratio in every generation. The above expectation was fulfilled in the offspring reared in 1916. (S. Table 2).

TABLE 2

Parents	Type of families	Observed	Expected
Full-awned	I	8	6.5
"	II	16	13.0
"	III	14	13.0
"	IV	24	26.0
Medium-awned	V	9	6.5
Rare-awned	VI	7	13.0
Total		78	78.0

In the first four classes shown in the above table, the goodness of fit between the observed and expected numbers is 0.725.

Deficiency of recessive individuals or at least such a tendency is very often met with in the Mendelian experiments, and here also it has been observed that the number of recessives (mutant form) is decidedly less than might be expected, while that of double dominants is in excess. The discussion on this point will be made later (VI, p. 44).

II. Crosses between the Type and the Mutants

The following crosses were made in order to confirm the genetic constitution of the mutant form.

Cross No.	Matings	Pedigree of parents
3	Medium-awned \times full-awned	SO-12, Pt. 1 \times SO-3, Pt. 2
4	" \times "	SO-12, Pt. 3 \times SO-3, Pt. 3
9	Full-awned \times awnless	SO-3, Pt. 3 \times SO-26
10	Medium-awned \times awnless	SO-12, Pt. 3 \times SO-21
11	" \times "	SO-3, Pt. 3 \times SO-26

Pt. = Plant

These crosses constitute a combination of each form of awn with the leaf and fertility characters. Plants used for the crosses were taken

from the constant families except awnless, roll-leaved plants which can only be obtained from the segregating families.

A. MEDIUM-AWNED \times FULL-AWNED ($NNbb \times NNBb$)

F_1 and F_2 : The F_1 hybrid should be heterozygous in respect to the factor B . Four F_1 plants were full-awned like the maternal parent. In the F_2 generation, full-awned and medium-awned appeared according to a monohybrid ratio, but the number of medium-awned plants was less than expected, as seen in Table 3.

TABLE 3

Parents	Full-awned	Medium-awned	Total	% medium-awned
Cross No. 3 (guarded)*	352	88	440	20.0
„ „ (unguarded)	398	94	492	19.50
Cross No. 4 (guarded)	480	140	620	22.58
„ „ (unguarded)	570	184	754	24.40
Total	1800	506	2306	21.94
Expected	1729.5	576.5		
Deviation	+70.5	-70.5		
Dev./P. E.	5.025			

*Seeds secured from the panicles guarded by the paper bags.

As already noticed, not only is the exact discrimination of the different classes of the awn somewhat difficult, but also the modification often masks¹ the true expression, hence a considerable amount of deviation must be admitted.

F_3 : The offspring of ten full-awned individuals from the cross No. 4, '18-1, guarded, indicated also the deficiency in the number of recessive individuals. There were four constant and six segregating families. On the basis of a monohybrid ratio, the expected numbers should be 3.33 and 6.67 respectively. These six segregating families gave the following results:

TABLE 4. (Sum of six families)

	Full-awned	Medium-awned	Total
Observed	397	104	501
Expected	375.75	125.25	501
Deviation	+21.25	-21.25	
Dev./P. E.	3.25		

Thus in F_2 and F_3 generations the segregating ratio of plants does not fit very well the expected 3:1 ratio. A better fit can be obtained on the basis of 3.1:0.9 instead of 3:1. The values of Dev./P. E. are 0.99 and 1.38 respectively on the basis of a 3.1:0.9 ratio, as compared with 5.025 and 3.25 on the basis of a 3:1 ratio.

B. FULL-AWNED \times AWNLESS. ($NNBB \times nnBB$)

F_1 and F_2 : The F_1 plants were phenotypically identical with the maternal plants, i. e. normal-leaved and full-awned. In the F_2 generation, normal-leaved full-awned and roll-leaved awnless plants segregated in a monohybrid ratio, but the recessive individuals were deficient when a 3:1 ratio was expected, as shown in Table 5.

TABLE 5

Parents	Normal-leaved, full-awned	Rolled-leaved, awnless	Total
Cross 11, '18-1 not guarded	107	16	123
" " guarded	91	25	116
" '18-2 not guarded	116	15	131
" '18-3 guarded	98	22	120
" " not guarded	91	27	118
" '18-4 guarded	96	29	125
" " not guarded	111	15	126
" '18-5 guarded	101	25	126
" " not guarded	106	18	124
" '18-6 guarded	91	16	107
" " not guarded	103	16	119
Total	1111	224	1335
Expected	1001.25	333.75	
Dev./P. E.	10.665		

F_3 : The F_2 families No. '19-6 and No. '19-7 are the offspring of the same F_1 plant ('18-4), but they showed a marked difference in the number of recessives. In the former, the percentage of recessives was 11.9 or 13.1 per cent less than expected, while in the latter 19.8 or 3.2 per cent less. Twenty families from each F_2 gave nearly equal proportion of recessives. It shows that the large deviation is not due to the genetic causes. See Tables 6 and 7.

TABLE 6. Sum of all F_3 families

Parents	Normal-leaved, full-awned	Roll-leaved, awnless	Total	% recessives
F_2 19-6	739	231	970	23.79
F_2 19-97	826	217	1043	20.81

TABLE 7

	Number of families			
	Offspring of '19-6		Offspring of 19-7	
	constant	segregating	constant	segregating
Observed	7	13	9	11
Expected	6.67	13.33	6.67	13.33
Deviation	0.33		2.33	

F_4 : We have selected again two F_3 families in which the recessive individuals were markedly deficient. The family No. '20-3 had 84 normals and 11 mutant forms, or 11.58 per cent recessives and the family No. '20-30 had 80 and 16 or 16.67 per cent recessives. The mean percentages of recessives in F_4 progenies of both families were 24.46 and 28.51 per cent respectively. The segregating ratios of families agreed with the normal ratio. See Table 8.

TABLE 8

	Number of families			
	Offspring of '20-3		Offspring of '20-36	
	constant	segregating	constant	segregating
Observed	13	27	14	26
Expected	13.33	26.67	13.33	26.67
Deviation		0.33		0.67

C. MEDIUM-AWNED \times AWNLESS. ($NNbb \times nnBB$)

F_1 and F_2 : Seventeen F_1 plants obtained were fertile, normal-leaved, and full-awned. In F_2 four classes of phenotypes appeared as we have expected. It is of interest to note that the proportion of four classes is the same as we have observed in the original mutant family *SO*. The observed numbers fit fairly well the expectation of a 10.75:1:2:2.25 ratio instead of that of 9:1:2:4, as shown in the following tables.

TABLE 9 A. Sum of all F_2 families.

	Normal-leaved, full-awned	Normal-leaved, medium-awned	Normal-leaved, rare-awned	Roll-leaved, awnless	Total
Observed	1590	157	291	351	2389
Expected*	1343.81	149.31	298.63	597.25	
Deviation	+246.19	+7.69	-7.63	-246.25	
Expected**	1605.11	149.31	298.36	335.95	
Deviation	-15.11	+7.69	-7.63	+15.05	
Dev./P. E.	0.976	1.038	0.844	1.313	

* 9:1:2:4

** 10.75:1:2:2.25

TABLE 9 B. Mutant family *SO*.

	Normal-leaved, full-awned	Normal-leaved, medium-awned	Normal-leaved, rare-awned	Roll-leaved, awnless	Total
Observed	62	7	9	10	88
Expected	49.5	5.5	11.0	22.0	
Deviation	+12.5	+1.5	-2.0	-12.0	
Expected	59.125	5.5	11.0	12.375	
Deviation	+2.875	+1.5	-2.0	-2.375	
Dev./P. E.	0.968	0.980	0.956	1.080	

Since the number of recessive individuals in each family is variable, the ratio of three awn classes is calculated on the normal-leaved plants only. The agreement is unsatisfactory, because the number of double dominants is in excess. See Table 10.

TABLE 10

Pedigree	Normal- leaved, full-awned (N-I)	Normal- leaved, medium- awned (N-II)	Normal- leaved, rare-awned (N-III)	Roll-leaved, awnless (R-S)	Total	% (R-S)
Cross 10, '18-1*	71	5	9	17	102	16.67
" " '18-2*	72	9	15	14	110	12.73
" " '18-3*	84	6	10	12	112	16.67
" " '18-4*	82	11	24	10	127	7.87
" " '18-5*	77	8	15	26	126	20.63
" " '18-6*	82	4	13	21	120	17.50
" " '18-7*	74	7	9	14	104	13.46
" " '18-8*	79	12	18	26	135	16.36
" " '18-9*	86	8	21	11	126	8.73
" " '18-10*	87	7	13	14	121	11.57
" " '18-11*	77	7	15	24	123	19.51
" " '18-12*	87	7	20	11	125	8.80
" " '18-13*	79	9	20	14	122	11.48
" " '18-14*	80	6	10	22	118	18.64
" " '18-15*	70	7	9	21	107	19.63
" " '18-16*	76	8	16	16	116	13.79
" " '18-17*	83	9	11	18	121	14.88
" " '18-18*	80	8	10	21	119	17.65
" " '18-19*	92	9	13	11	125	8.80
" " ?						
Total	1590	157	291	351	2389	14.69
Expected (9:1:2)	1528.5	169.83	339.67			
Deviation	+61.5	-12.83	-48.67			
Dev./P. E.	4.66	1.53	4.29			

(*) guarded.

F_3 : The offspring of the fertile, full-awned plants from F_2 families No. 1 and No. 8 (Cross No. 10, '18-1 and '18-4) show approximately a 1:2:2:4 ratio which is demanded by the normal dihybrid segregation. The values of Dev./P. E. are permissible but the goodness of fit is poor, $P=0.112$. (S. Table 11).

TABLE 11

Type of families	Number of families				Dev.	
	Offspring of No. 1		Offspring of No. 8		Total	Expect. P. E.
<i>NNBB</i>	6	13.95 %	10	20.41 %	16 10.222 %	11.11 % 2.47
<i>NNBb</i>	3	6.98 %	10	20.41 %	13 20.444 %	22.22 % 2.77
<i>NnBB</i>	13	30.23 %	8	16.33 %	21 20.444 %	22.22 % 0.23
<i>NnBb</i>	21	48.84 %	21	42.86 %	42 40.888 %	44.44 % 0.51
Total	43		49		92	

As shown in the above table, the proportion of *NNBb* and *NnBB* families in the two different lines of descent deviates distinctly from the normal proportion. The segregating ratio of plants within the families is also abnormal as elsewhere mentioned, because the number of recessive individuals is deficient. In the total of 42 families which segregated out four classes, the percentage of double recessives is 16.07 whereas in the sum of all the F_2 's, we had 14.69. Even in the normal-leaved plants alone, the agreement is not very close (s. Table 12). The segregating ratio of plants within each family is much more variable than the family ratio and the latter give fairly reliable ratios. Further discussion will be made in VI (p. 44).

TABLE 12. (Sum of 42 families)

	Normal-leaved, full-awned	Normal-leaved, medium-awned	Roll-leaved, rare-awned	Roll-leaved, awnless	Total
Offspring of No. 1	1072	138	219	259	1688
„ No. 8	886	133	215	251	1488
Total	1958	271	434	510	3173
Cal. (9:1:2)	1997.25	221.91	443.84		
Dev./P. E.	2.604	5.186	0.759		

The medium-awned, normal-leaved plants of F_2 should be constant as their factor composition is $NNbb$, and in fact nineteen F_3 families from such F_2 plants were found to be constant. The rare-awned plants should be heterozygous, hence they should throw three kinds of plants, $NNbb$, (medium-awned), $Nnbb$ (rare-awned), and $nnbb$, (awnless sterile). Twenty-one families without exception gave these kinds of plants.

Thus the conclusion may be drawn out that the genetic composition of the original mutant which gave birth to the family SO and that of the offspring derived by various crosses among the individuals of the latter are essentially the same to each other and the assumed factor composition is the correct one in so far as the evidence indicated by the family ratio in the third generation shows us.

III. Roll-leaved Fertile Mutant

This family (F_5 No. 56= NK) was discovered in 1916 among the F_5 families of the same cross in which the staminoidal mutant was discovered in the previous year. There were planted 60 families and the family No. 56 was one of the offspring derived from F_4 family No. 67. The mutant appeared as Mendelian segregate, as it is the case with the staminoidal sterile mutants. In this family, the mutant is roll-leaved, but variously awned and only partially sterile to a low degree. Some of the spikelets are abnormal. There are found two to three abnormal, extra ovaries



Fig. 5. Left, "Daikoku", dwarf; right, roll-leaved fertile mutant (NK family).

within a single spikelet, each of which has a well developed stigma. Sometimes deformed extra anthers are also found. The rollness of the leaf is far less pronounced than in the sterile mutant, for they are simply twisted at the base of the blade (see fig. 5, right). But there occurs a definite relation between the length of the awn and the leaf character. The full-awned and medium-awned are found only among the normal-leaved plants, and in the roll-leaved plants two kinds of awn classes can be distinguished. One of them is intermediate between medium- and rare-awned, and the other is truly rare-awned. The former is designated Class II, or *next-medium-awned*.

In respect to the leaf character, this mutant family (*NK*) showed a monohybrid segregation, the mutant character being recessive to normal, and in combination with the awn character, the whole segregation was a dihybrid one, giving a 9:3:3:1 ratio as shown in Table 13.

TABLE 13

	Normal-leaved, full-awned	Normal-leaved, medium-awned	Normal-leaved, next-medium	Roll-leaved, rare-awned
Observed	49	24	18	3
Expected	52.83	17.61	17.61	5.87
Deviation	-3.83	+6.39	+0.39	-2.89
Dev./P. E.	1.18	2.504	0.153	0.574

The mutant factor is n' which is recessive to the normal factor N . A single heterozygote $Nn' Bb$ which arose by the mutation among the F_4 individuals, does not differ from the normals in the phenotypic expression since the mutant characters are recessive to the normal. The heterozygous individual $Nn' Bb$ should produce the following offspring:

Type of families	Phenotypes	Genotypes	Ratio
Type I	normal-leaved, full-awned	$NNBB$	1
" II	" "	$NNBb$	2
" III	" "	$Nn'BB$	2
" IV	" "	$Nn'Bb$	4
" V	normal-leaved, medium-awned	$NNbb$	1
" VI	" "	$Nn'bb$	2
" VII	roll-leaved, next-medium-awned	$n'n'BB$	1
" VIII	" "	$n'n'Bb$	2
" IX	roll-leaved, rare-awned.	$n'n'bb$	1

All these types were actually found in 94 families reared in the next year. (S. Tables 14 and 15)

TABLE 14

Type of families	Number of families		Deviation	Dev./P. E.
	Observed	Expected		
I	5	5.8125	-1.8125	0.516
II	7	11.625	-3.375	1.569
III	15	11.625	+3.375	1.569
IV	21	23.25	-2.25	0.7999
V	6	5.8125	+0.1985	0.126
VI	13	11.625	+1.375	0.639
VII	7	5.8125	+0.11875	0.754
VIII	16	11.625	+4.375	2.034
IX	3	5.8125	-2.8125	1.787

$$\chi^2 = 5.9226 \quad P = 0.6558$$

The deficiency of the number of double recessives has been noted in the family groups III and VI, but in IV and VIII the normal ratio has been observed.

TABLE 15

A. Sum of 15 families, group III.						
	Normal-leaved, full-awned	Normal-leaved, medium-awned	Normal-leaved, next-medium	Roll-leaved, rare-awned	Total	Dev. P. E.
Observed	1193	—	315	—	1508	
Expected	1131	—	377	—		5.64
B. Sum of 13 families, group VI.						
Observed	—	1002	290	—	1290	3.05
Expected	—	970	322	—		
C. Sum of 16 families, group VIII.						
Observed	—	—	1068	381	1446	
Expected	—	—	1086.75	362.25		1.69
D. Sum of 21 families, group IV.						
Observed	1159	425	400	144	2128	
Expected	1197	399	399	183		
Dev./P. E.	2.46	2.14	0.08	1.46		

IV. Rolled-Leaved Sterile (Staminoidal-Sterile) which arose in the Progeny of Roll-leaved Fertile

The staminoidal sterile was discovered in 1917 in one of the segregating families of the offspring of the normal-leaved fertile plants of the *NK* family, which, as already described, came to our notice in the previous year. Like the case of *SO* mutant, sterility, awnlessness and rollness of the leaf are completely linked. The pedigree number is family No. '17-28, which is entered as *NO* family in our record. Thus we have two strains of staminoidal sterile mutants, *SO* and *NO* respectively. (Table 16).

The mutant forms appeared also as Mendelian segregates, and the rollness of the leaf became again much pronounced as in the *SO* mutants.

TABLE 16

	Full-awned	Medium-awned	Rare-awned	Awnless	Total
Normal-leaved	51	12	19	—	82
Roll-leaved	—	—	—	20*	20
Total	51	12	19	20	102
Expect. (9:1:2:4)	57.375	6.375	12.750	25.50	
Dev.	-6.335	+5.625	+6.25	-5.5	
Dev./P. E.	1.842	0.941	0.541	0.288	

* Two plants bore one fertile grain on each.

As already shown, the roll-leaved, fertile mutant should be $n'n'$, and the normal-leaved sterile (staminoidal sterile) nn . The parental plant of this family therefore must be heterozygous i. e., $NnBb$ which might have arisen by the factor mutation either from the homozygous individual NN to Nn , or from the heterozygous individual Nn' to Nn .

It was observed that two of these roll-leaved awnless plants bore a single, fully matured grain on each. These two fertile grains must have been originated by the reverse mutation which occurred in the somatic cells of nn constitution, in which the formation of normal stigma is impossible and, as we have already seen, the sterility is due to its absence. Since the stigma is composed of diploid cells, there can be no other possible interpretation than the somatic mutation in virtue of which the stigma was made possible to receive the pollen. Particular attention has been given to such fertile grain which might be found in the nn plants in the subsequent generations, but none of such ones has been discovered.

The offspring of the normal-leaved, full-awned plants gave the following result which is in accord with the expectation.

TABLE 17

Family groups	Number of families			Dev./P. E.
	Observed	Expected	Deviation	
I	7	5.222	+1.778	1.392
II	9	10.444	-1.444	0.762
III	12	10.444	+1.556	0.821
IV	19	20.888	-1.888	0.822

$$\chi^2 = 1.2075 \quad P = 0.7538$$

Twenty families from medium-awned plants were all constant, and

sixteen families from rare-awned plants gave three classes of plants, as expected. The deficiency of the double recessive plants became again distinct. The experiments have been continued for further two generations, and the results obtained have been similar to those found in the progeny of *SO* family.

V. Roll-leaved Fertile \times Staminoideal Sterile

The relation between two mutants, roll-leaved fertile and roll-leaved sterile (staminoideal sterile) has been studied by means of the following crosses:

Cross No.	Mating	Pedigree
No. 16-5	Roll-leaved fertile \times roll-leaved sterile	NK, 16-56 \times SO, 16-52
No. 16-6	Roll-leaved fertile \times roll-leaved sterile	NK, 16-56 \times SO, 16-53

F_1 : The roll-leaved next-medium-awned fertile plants, taken from the family No. 16-56 were fertilized with the pollen of the roll-leaved, staminoideal sterile plant from the family No. 52 and No. 53 respectively. Both families were heterozygous in respect to the factor for the mutant character as well as the stature of the plant.⁽¹⁾ The F_1 plants were highly sterile, over 85 per cent of the total spikelets being empty.

F_2 : The fertile grains from the highly sterile F_1 plants produced three classes of plants, i. e., fertiles, partial steriles like F_1 , and complete steriles (staminoideal steriles) in 1:2:1 ratio. (S. Table 18.)

In respect to the stature of the plant, F_2 families from the cross No. 5, plant I and cross No. 6, plant I produced normal and dwarf individuals.

F_3 : The fertiles should be homozygous for n' , and they produced fertile progenies only with few exceptional sterile plants which can be regarded as mutants or abnormal individuals. The partial steriles should

(1) The actual number is as follows:

Family No.	Normal stature		Dwarf stature	
	normal-leaved	roll-leaved	normal-leaved	roll-leaved
No. 52	106	22	40	8
No. 53	95	29	29	8

TABLE 18

Cross No. 5	Fertile	Partially sterile	Completely sterile	Total
Plant I	10	17	4	31
Plant II	11	9	10	30
Plant III	11	16	9	36
Cross No. 6, Plant I	3	12	—	19
Total	35	58	23	116
Expected (1:2:1)	29	58	29	
Deviation	+6	0	-6	

be heterozygous for n' . Owing to the high degree of partial sterility, the offspring from the individual plants were so small in number that no definite ratio can be calculated. Nevertheless it can be seen that three expected kinds of plants are present, and when we sum up all the families, the ratio of fertiles and partial steriles against complete steriles is 3:1. (S. Table 19).

TABLE 19. (Sum of 16 families)

Progeny	Fertile and part. sterile	Sterile	Total
Cross No. 5, Pt. I	6	2	8
„ „ Pt. II	7	4	11
„ „ Pt. III	14	2	16
Cross No. 6, Pt. I	2	0	2
Total	29	8	37
Expected (3:1)	27.75	9.25	

Consequently three forms, i. e., normal and its two mutant forms are due to three factors, and they constitute a system of multiple allelomorphs. Thus three forms can be represented as follows:

NN	normal-leaved and fertile
$n'n'$	roll-leaved and fertile
nn	roll-leaved and completely sterile due to staminody.

VI. Probable Causes of Deficiency in the Number of Mutant Forms

Mention has already been made about the deficiency of recessive (sterile-mutant) plants in the segregating progenies of *SO* and *NO* families. Recessive individuals often appear in a proportion markedly less than that might be expected on the basis of Mendelian segregation. The case of *Capsella* studied by SHULL (1914), for example, is one of the typical cases. He interpreted that it is due to the different survival values between the dominant and the recessive individuals. The inheritance of four characters of peas studied by MENDEL himself and later by BATESON, Miss KILLBY, DARBISHIRE and especially by YULE (1923) is perhaps the most interesting case of the same category, but the satisfactory answer has yet to be awaited.

On examining the foregoing data, it can be seen that in the offspring of $NnBb$, the number of families homozygous for N and B exceeds almost always the number expected on the basis of a normal segregating ratio. The foregoing fact indicates that the heterozygous condition for two factors is in some way connected with the causes which tend to increase the number of homozygous dominant individuals. Thus the condition is in many respects similar to that in the case of DARBISHIRE's pea as depicted by YULE (1923). YULE's analysis shows that the proportions of four kinds of peas do not conform to the proportions of the Mendelian dihybrid, the excess of double dominants and deficiency of double recessives being observed both in seed and plant proportions, which is just the same in our case. He found that the divergence is not so significant in the case with monohybrids than in that of dihybrids, and such is just the same in our material.

Further he has shown that the different lines of descent do not give homogeneous progenies, and such tendency has also been observed by us. The differential survival values play only subsidiary rôle in pea, so with the case of our material, as we shall see presently.

It has been found in the first place that there occurs no selective viability of the seeds and the seedlings between those of the type as well as the mutants. The percentage germination is just as high in the seeds borne by the heterozygous plants for the mutated factor as

in those of the homozygous normal plants: both of them give over 90 per cent germination when tested on the moist sand bed kept in the laboratory. Nor does the number of seedlings which die after germination in the seed bed on the paddy field up to the time of transplanting differ at all in the seedlings reared from the plants homozygous and heterozygous for *N*: both lots show likewise 98 per cent survival at the time of transplanting.

In the next place the count has been made of the number of plants surviving at the time of harvest, and it has been found that a considerable number of both the normal and roll-leaved recessive plants die. In a control experiment, the percentage of the dying plants was found to be 2.75 and 1.57 in the families which segregate out the mutant form, and constant normal families respectively, the difference being 1.2 per cent.

We have made the counts of the empty seeds (spikelets) on the

TABLE 20

Family No.	Parent plant		Offspring from fully matured grains	
	No. of plants examined	Mean per cent imperfect grains	Mean per cent in plants	Total No. of plants
58	6	13.58	22.62	643
114	10	11.49	25.38	1189
122	5	15.07	30.63	586
124	4	21.89	24.32	661
127	5	9.76	23.60	706
118	5	10.88	22.81	631
62	5	7.90	23.40	723
61	5	8.36	24.14	670
44	10	8.17	23.42	1571
48	7	10.28	25.35	1105
69	8	8.75	25.73	1136
76	10	7.89	21.95	1499
Total	80	Mean 11.17 $\sigma = \pm 3.91$	Mean 24.45 $\sigma = \pm 2.18$	11120

panicles of homozygous and heterozygous (Nn) plants. The rare-awned, normal-leaved plants are heterozygous and produce three kinds of seeds, NN , Nn and nn , while the normal medium-awned plants are homozygous for the factor N , producing only one kind of seeds NN . The mean percentages of imperfect seeds borne by the Nn and NN plants are 10.51, $\sigma = \pm 5.06$ and 10.24, $\sigma = \pm 4.53$ respectively. The difference is only 0.27 per cent higher in the heterozygous plants than in the homozygous ones. (S. Table 20).

If homozygous seeds nn were actually more inviable than Nn or NN seeds, we should expect to have a definite correlation between the percentage of imperfect seeds and the deficiency in the number of nn plants in the offspring. The control experiment however showed that there exists no such relation.

The coefficient of correlation between the percentage of imperfect seeds and the mean percentage of recessive plants in the offspring is +0.24. It shows that there occurs a slight tendency of producing more recessive plants in the offspring of the plants which have more imperfect seeds, which is contrary to what might be expected.

TERAO's studies (1917, 1921, 1922) show that in his materials the reversible mutations occurring in the somatic cells give rise to the deviation in the segregating ratio of the plant and the family as regards the characters concerned. He took pains to demonstrate in a quantitative manner the discrepancy due to unequal number of gametes formed by the assumed somatic mutation. When the change $a \rightarrow A$ occurs in the somatic cells the number of a gametes produced would be reduced, hence causing the decrease of the recessive individuals and the increase of the homozygous dominant individuals.

Certainly a similar anomaly may play a rôle in the present case, but the quantitative relations differ in the two cases. If the formation of the dominant homozygous individuals is more frequent than that of the homozygous recessive individuals in such a manner as to maintain a certain quantitative relation in general, we can estimate approximately such deviation that can be observed in the experimental results. Suppose that we will make the selfing of the heterozygous dominants, then the consequence is such that as if the functional gametes N and n are in the proportion $1+x:1-x$ instead of $1:1$, which will give NN , Nn and nn in the following ratio, namely, $(1+x)^2$, $2(1+x)(1-x)$ and $(1-x)^2$. Putting $x=0.1$, then $NN=1.21$, $2Nn=1.98$ and $nn=0.81$ per 4. Calculating the observed numbers of families according to the

above ratio, a better agreement can be found than that obtained according to the normal ratio.⁽¹⁾ Of the sum of 289 families* which are the offspring of *NnBb* in the foregoing experiments elsewhere discussed, the following agreement is obtained. (S. Table 21.)

TABLE 21

Family group*	<i>NN</i>	<i>Nn</i>	Total	Cal. <i>NN</i> (1:2)	Dev./P. E.	Cal. <i>NN</i> (1.21:1.98)	Dev./P. E.
A	24	38	62	20.7	+1.137	23.518	+0.192
B	9	34	43	14.3	-2.59	16.311	-3.506
C	20	29	49	16.3	+1.662	18.587	+0.635
D	16	31	47	15.7	+0.138	17.828	-0.839
E	24	27	51	17.0	+2.986	19.344	+2.145
F	7	12	19	6.3	+0.772	7.207	-0.149
G	8	10	18	6.0	+0.242	6.828	+0.868
Total	108	181	289	96.33	2.59	109.62	0.291
Deviation				11.67		1.62	

* A *SO* mutant family 1916.

E „ fourth generation, 1919.

B Cross No. 10 F_3 No. 1.

F „ „ „ „

C Cross No. 10, F_3 No. 8.

G „ fifth generation, 1920.

D *NO* mutant third generation, 1918.

Distributing these families within the range of Dev./P. E. we get:

Dev./P. E.	-4	-3	-2	-1	0	+1	+2	+3	+4	Total
Cal. 1:2 ratio			1			3	2	1		7
Cal. 1.21:1.98 ratio		1			2	3		1		7

Similarly, the dihybrid proportion becomes:

(1) The present supposition is tentative. The selective fertilization among the different kinds of gametes which are produced in equal proportion would bring about the same sort of aberrant zygotic ratio as would be realized by the random mating between the different kinds of gametes, which are produced in unequal proportion. No experimental evidence has yet been obtained to give a definite conclusion.

TABLE 22

Family groups	A	B	C	D	E	F	G	Total	Cal. (norm.) (abnorm.)	
I (<i>NNBB</i>)	8	6	11	7	10	2	2	45	32.111	36.61
II (<i>NNBb</i>)	16	3	10	9	14	5	6	63	64.222	73.21
III (<i>NnBB</i>)	14	13	8	12	12	25	3	64	64.222	59.72
IV (<i>NnBb</i>)	24	21	21	19	15	10	7	117	128.445	111.45
Total	62	43	49	47	51	19	18	289	289	289
χ^2									6.22	3.73
P									0.103	0.297

In the case of the mutant family *SO* alone, the agreement is better on the proportion somewhere at 1.2:0.8. Compare the figures below:

TABLE 23

a. Segregation of *SO* family. Plant proportion

Phenotypes Cal. ratios	Normal- leaved, full-awned	Normal- leaved, med.-awned	Normal- leaved, rare-awned	Roll-leaved, awnless	χ^2	P
1:1 (normal)	49.5	5.5	11.0	22.4	36.89	0
1.1:0.9	52.63	6.66	10.89	17.82	20.39	0.00015
1.2:0.8	55.44	7.92	10.56	14.08	2.3	0.518
Observed	61	7	9	10		

b. Family ratio. Offspring of *SO* family

Family groups Cal. ratios	<i>NNBB</i>	<i>NNBb</i>	<i>NnBB</i>	<i>NnBb</i>	χ^2	P
1:1 (normal)	6.86	13.78	13.78	27.55	1.18	0.76
1.1: 0.9	7.85	15.71	12.81	25.63	0.40	0.92
1.23: 0.77	9.09	18.12	11.57	23.22	0.9	0.82
Observed	8	16	14	24		

As already mentioned, the classification of two types of awn, i. e., full and medium is less reliable than that of the leaf types, so that much weight may not be given to the observed proportion of the awn classes. But if we make the same sort of calculation as we have done just now, the similar result can be obtained. Thus:

TABLE 24

Family groups*	<i>B B</i>	<i>B b</i>	Total	<i>B B</i> cal. (1:2)	Dev./P. E.	<i>B B</i> cal. (1.21:1.98)	Dev./P. E.
A	22	40	62	20.667	+0.532	23.517	-0.589
B	19	24	43	14.333	+2.238	16.310	+1.253
C	18	31	49	16.333	+0.749	18.586	-0.256
D	19	28	47	12.333	+3.058	17.828	+0.522
E	22	29	51	13.667	+1.683	19.345	+1.136
F	4	15	19	6.337	-1.683	7.207	-2.247
G	5	13	18	6.000	-0.741	6.828	-1.316
Total	109	180	289	96.33	+2.344	109.621	0.112
Deviation				+12.67		-0.621	

It follows therefore, that the observed proportion of zygotes be such that as if it shows the result of random mating of four kinds of gametes,

TABLE 25

	Observed	Cal. (normal)	Dev.	Cal. (differential)	Dev.
<i>NNB B</i>	45	32.11	+12.89	42.63	+2.37
<i>NNB b</i>	63	64.22	- 1.22	68.37	-5.37
<i>Nn B B</i>	64	64.22	- 0.22	68.37	-4.37
<i>Nn B b</i>	117	128.44	+11.44	109.63	+7.37
Total	289	288.99		289.00	
χ^2			6.2227		1.3266
P			0.1028		0.7265

the proportion of which corresponds to the assortment of each factor having different combining values. If we put the combining values of $N=1.11$, $n=0.89$, $B=1.11$, $b=0.89$, then $NB=1.11 \times 1.11$, $Nb=1.11 \times 0.89$, $nB=1.11 \times 0.89$, $nb=0.89 \times 0.89$, or $1.2321:0.9879:0.9879:0.7921$, the calculated numbers based on this ratio is as in Table 25, p. 49.

If the proportion of homozygous and heterozygous individuals are examined on the offspring of the heterozygous plant for the factor N alone, the above condition is no longer held. On the contrary the homozygous families tend to appear less than the normal ratio. The offspring of $NnBB$ plants of SO family shows:

TABLE 26

Number of families			
NN	Total	Cal. NN (normal ratio)	Dev.
8	20	6.67	+1.33
4	18	6.00	-2.00
6	20	6.67	-0.67
4	20	6.67	-2.00
6	21	7.00	-1.00
Total 28	99	33.00	-5.0
Dev./P. E.			1.51

The heterozygous plant $Nnbb$ gives three kinds of offspring and their proportions can be tested in the same way as has been done before. The $NNbb$ (medium-awned) and $Nnbb$ (rare-awned) should be on a 1:2 ratio if the normal ratio is maintained, but a slight excess of homozygous individuals is persistently observed. Thus:

TABLE 27

Dev./P. E.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	Total	χ^2	P
Cal. A			2	6	9	16	11	11	8	1	64	61.9	0
Cal. B		2	4	7	16	14	10	11			64	6.78	0.34

The upper distribution in Table 27 is calculated on 1:2 ratio or random mating of equal proportion whereas the lower one is calculated on 1.05:0.95 ratio. The calculation on the basis of proportion higher than this gives no better fit.

Certain figures given by YULE (1923) regarding the proportions of four kinds of peas studied by DARBISHIRE have been calculated in similar manner. The result shows likewise the closer agreement of observed and calculated numbers than when calculated according to the normal ratio.

The present analysis of the problem is incomplete and no definite conclusion can be drawn, nevertheless it can be seen that the observed divergence corresponds to the supposed divergence in the gametic ratio, suggesting that some unknown factors which tend to disturb the normal distribution of different kinds of gametes is operating at least in part, as the chief causes. We have met with difficulties due to the characters which are not suitable to such a study as this. An intensive study with suitable material is urgently needed to solve the question.

Additional Notes

The cytological examination has been made with the limited number of materials on the staminoidal sterile and roll-leaved, fertile mutants. They have the same number of chromosomes as the normal plants; the diploid number is 24 and the haploid 12. NAKATOMI (1923) has shown that a number of existing aberrant forms other than those here communicated, have the same number of chromosomes as that of many other normal varieties examined. These observations lead to the conclusion that the mutations in the cultivated rice are chiefly caused by the factor mutations rather than by the chromosomal aberration, while in wheat, maize and mulberry, the varietal difference due to the chromosomal number is known.

Adverse growth condition may sometimes induce similar abnormal development of spikelets as those arising by the genetic factors. As early as 1896 HORI (1896) reported the occurrence of widely distributed disease due to physiological causes. His figures (see his Plate I and II) show that the spikelets of the diseased plants are quite similar to our staminoidal sterile and other sterile mutant which will be reported in a separate paper. He considered that abnormal development is due to an excess of nitrogenous manure, influence of sewage water, sudden water supply after prolonged draught, etc.

YAMASAKI (1923) also observed a similar anomaly in the shoots which were produced by the secondary growth of the remains after the harvest and which were kept in the green house throughout the winter. He considers that insufficient supply of heat in winter may be one of the chief causes.

Summary

Two mutant forms, *staminoidal sterile*, and *roll-leaved fertile* are described. In the former, leaves are rolled, awnless, and completely sterile owing to staminody. In the latter, leaves are rolled also but less markedly, awned and only slightly sterile. Both of them have arisen from the progenies of the hybrid between the normal-leaved awned fertile variety of normal stature on the one hand and normal-leaved, awned fertile dwarf variety on the other.

The factor for the normal-type form from which these mutants arose, can be represented by N and those of roll-leaved, staminoidal mutant and roll-leaved fertile mutant by n and n' respectively. These three factors constitute a multiple allelomorph.

In one case n arose from N directly while in other instance N changed at first to n' and then to n so that the change has wanted two successive generations.

The factor B modifies the development of awn, acting complementary to N and n' , but has no effect with n .

In the progenies of the plants heterozygous for both factors N and B , the segregating ratio tends to deviate from the expectation based on the normal Mendelian ratio. The double dominants are in excess and the double recessives are deficient in the plant ratio, while the homozygous double dominants are in excess and the heterozygotes for both factors are deficient in the family ratio.

The divergent proportion above mentioned corresponds to the supposed divergence in the proportion of different kinds of gametes formed which make a random sampling.

It is my pleasant duty to express my thanks to Messrs. S. NAKATOMI, T. NIBE and G. INADUKA for their kind assistance.

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Studies on the Mutations in *Oryza sativa* L.

II. On Awned Sterile, Compact-panicked and Dwarf Mutants

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With 2 Text-figures

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I. Awned Sterile

A second type of complete sterility, *awned sterile* has been discovered in 1922 in the progenies of a cross between the medium-awned fertile and the awnless, staminoidal sterile of *S O* mutant family, which has already been reported in the previous paper (NAGAI 1926, p. 25 ff.).

The mutants have been found in the segregating family for the factor *N*. They are completely sterile but fully awned and the shape of the paleas is not modified as it is the case with the staminoidal sterile mutants. The awned sterile behaves as recessive to the normal fertile, and the factors concerned may be represented by *s* and *S* respectively.

When the normals heterozygous for both factors, i. e., *NnSs* is selfed, three types of plants, i. e., normal-leaved fertile (*NS*), normal-leaved awned sterile (*Ns*), and roll-leaved staminoidal sterile (*nS* and *ns*) segregate out in the offspring approximately in the 9 : 3 : 4 ratio, but no roll-leaved, awned steriles appear. The factor *S* is therefore no effect without *N*, which is the ground factor for the normal development of the spikelets. The observed segregation is as follows:

TABLE 1

	Normal-leaved fertile	Normal-leaved awned sterile	Roll-leaved staminoidal	Total
Observed	422	136	145	1701
Expected	394.5	131.4	175.3	1701
Deviation	27.7	4.6	32.3	

The deviation of observed and expected numbers is partly due to the usual deficiency of staminoidal sterile plants which appear also in this case. If we take the normal-leaved plants alone, the ratio of fertile to awned sterile is 3:1. The expected numbers are 418.5 and 139.5 where we have really 422 and 136, so that the deviation=3.5, P. E.=0.5.

The *NNSs* plants would give the segregation in respect to sterility alone. In the sum of 7 such families reared in 1923, we obtained 425 fertiles and 103 steriles, where we expect 395.5 and 171.75 respectively. The deviation is 29.75 and Dev./P. E.=4.44, so that the recessives are again deficient in number.

The proportion of four kinds of families found in the offspring of normal-leaved fertiles in 1924 shows a close approximation to the 1:2:2:4 ratio, although a considerable deviation has been observed in the sampling in the subgroups. (S. Table 2).

TABLE 2

Kind of families Family No.	<i>NNSS</i>	<i>NNSs</i>	<i>NnSS</i>	<i>NnSs</i>	Total
1- 25	3 2.67	6 5.33	3 5.33	12 10.67	24
51- 75	16	—	7	2	25
76-100	2 2.18	5 5.55	3 5.55	15 11.11	25
101-125	3 2.18	8 5.55	5 5.55	9 11.11	25
126-150	6 2.18	5 5.55	2 5.55	12 11.11	25
Total	14	24	13	48	99
Calc.*	11.0	22.0	22.0	44.0	
Dev.	+3	+2	-9	+4	

* Exclusive of Nos. 51-75.

It has been observed that a certain number of caryopsis in the awned-sterile plants develop parthenocarpically and reach a full size of the matured grain. These caryopsis are empty, lacking the embryo and the endosperm, but simply filled with a clear liquid. In one of the

families, such parthenocarpic ones reach 9.9 per cent of total spikelets examined which are over 1900.

The pollen grains produced by the awned-sterile plants are **entirely** abortive but many of them retain the shape of the healthy ones, while the abortive pollen grains are generally shrivelled.



Fig. 1. Two panicles on the left side normal form; three panicles on the right compact-panicked mutants.

The ovules of the awned sterile plants are however functional, and they can be fertilized by the pollen of the normal plant. Thus in the case of staminoidal sterile, the ovules, and in the present case, the pollen grains are abortive.

II. Compact-panicked Mutant

The compact-panicked is a recessive mutant discovered in the F_4 progenies of the cross between the normal-leaved fertile and the staminoidal sterile (Cross No. 10), in which the awned sterile has also been discovered. The panicle of this mutant is short and dense resembling the panicle of the dwarf form (see fig. 1). The height of plant is also reduced but not so much as in the case of the true dwarf, being about half as tall as in the normal. The grain is also reduced considerably in length.

At first these mutants

were discovered as rare individuals among eight out of 128 F_4 families, the progenies of both NN and Nn plants. The actual numbers are as follows:

TABLE 3

F_4 family no.	Total plants	Compact-panicked	% compact-panicked	% staminoidal sterile
17	66	3	4.55	0
45	93	2	2.15	29.76
80	69	1	1.45	0
85	100	2	2.00	0
90	61	1	1.64	14.58
95	83	5	6.02	13.25
117	55	1	1.82	14.55
120	114	1	0.82	13.16
	641	16	2.49	

The offspring of forty normals from family No. 45 were reared in the next year. There were eight families which again produced the compact-panicked but the rest of them, 32 in all, were without them. In the sum of these eight families, 123 plants were compact-panicked out of 860 individuals, or 14.30 per cent of the total, appearing both in normal-leaved and roll-leaved plants (staminoidal sterile). (S. Table 4).

TABLE 4

F_5 family no.	Total plants	Compact-panicked	% compact-panicked	% staminoidal sterile
5	90	8	8.89	14.44
7	102	14	13.73	15.69
14	93	20	21.51	24.00
15	98	12	12.24	0
24	99	23	23.23	0
25	90	19	21.21	15.56
34	91	12	13.13	14.56
37	97	15	15.46	20.59
	860	123	14.30	

Still larger number of plants have been reared in 1923 from the family No. 5. It was found that the compact-panicled is a simple recessive, as we see from its proportions both in plant and family numbers. Thus:

TABLE 5

Kind of families	Total plants	Compact-panicled	% compact-panicled
<i>NN</i> families	1013	240	23.65
<i>Nn</i> families	1887	374	19.82
Total	2900	614	21.17

The ratio of homozygous and heterozygous families also agrees fairly well with a 1:2 ratio when the leaf character is not considered. There were 22 homozygous and 33 heterozygous families where 18.33 and 36.67 are expected. The deviation is 3.67, Dev./P. E.=1.6.

Thus it appears that the compact-panicled mutant is recessive to the normal form and the factors may be represented by *k* and *K* respectively. The relation of two pairs of factors *N*, *n*, and *K*, *k* is independent, since the progenies of the normal-leaved, fertile plants gave the following result in the next year which shows a fairly close approximation to the dihybrid proportion. (S. Table 6).

TABLE 6

Pedigree	Kind of families				Total
	<i>NNKK</i>	<i>NnKK</i>	<i>NNKk</i>	<i>NnKk</i>	
No. 7 1-25	4	5	4	12	25
No. 13 26-50	4	2	6	13	25
No. 19 51-75	9	5	3	8	25
No. 46 76-100	—	9	3	13	25
Total	17	21	16	46	100
Expected (1:2:2:4)	11.1	22.2	22.2	44.4	
Deviation	+5.9	-1.2	-6.2	+1.6	

The manner by which the mutant individuals appear in the last three generations deserves a particular attention. The mutants appeared at first as rare sports, being observed only in 2.49 per cent of the total population of families in which they have been found. In the next year they increased to 14.30 per cent of the total of the families in which they were found. In the third generation they reached 21 per cent. Thus in the first generation (family No. 45) the percentage ratio of KK , Kk , and kk may be 78.28 : 19.57 : 2.15 judged from the family ratio in the succeeding generations. In the next generation the ratio of KK and Kk in families were 22 to 33 or 40 to 60 per cent, hence the proportion of KK , Kk , and kk in family No. 45-5 may be 36.44 : 54.67 : 8.89 respectively. In other words, the ratio of KK and Kk in the two successive generations has been shifted from 1 : 0.25 to 1 : 1.5.

The consideration of the foregoing data leads us to the assumption that the gametic proportions may undergo the change from one generation to another tending for the normal proportion or 1 : 1 which will be described below.

The observed proportion of the normal and the mutant form in the first year was 97.5 : 2.5 per cent, as already shown. The progeny of the normal plants (family No. 45) showed 22 KK and 8 Kk or 78.3 : 19.6 per cent. If we assume that the proportion of K and k gametes was 1.68 : 0.32 or 84 : 16 per cent of the total number of gametes, instead of 1 : 1 or 50 : 50 per cent which the normal heterozygotes would produce, the result of random mating of such uneven number of gametes would give the zygotes in the following proportion per 100:

$$KK \ 72.25, \ Kk \ 25.50, \ kk \ 2.25$$

Then, the calculated numbers of KK and Kk are 8.8 and 31.2, while we found 8 and 32 as already mentioned. The agreement of observed and calculated numbers both in the plant and family ratio is very close. The proportion of homozygous and heterozygous individuals in family No. 45 (F_4) would then be:

	KK	Kk	kk
Calculated	72.25	25.50	2.25%
Observed	78.28	19.57	2.15%
Deviation	-6.03	+5.93	+0.10

In the following generation, the proportion of K and k gametes produced by Kk plants is supposed to approach more closely to 1 : 1 than it was the case before. We observed 14.3 per cent mutants in

average, and 8.89 per cent in family No. 5. If the proportion of K and k gametes is 1.24 : 0.76 or 62 : 38 per cent, a random mating would give 14.44 per cent kk plants where we had found 14.3 per cent, and among the normal plants the proportion of KK and Kk would be 44.85 : 55.15 per cent respectively. The observed number of families showed that there were 22 KK and 33 Kk or 40 : 60%. The expectation according to the assumed gametic ratio is 24.67 KK and 30.33 Kk , with deviation 2.67. Thus:

	KK	Kk	kk
Calculated	38.44	47.12	14.44%
Observed	36.44	54.67	8.89%
Deviation	+2.00	+7.55	+5.55

The agreement is again close. However, on the basis of a normal monohybrid ratio, the expected numbers of KK and Kk families are 18.33 and 36.67 with deviation=3.67, Dev./P. E.=1.6, as already shown. Comparing the above two calculations, the fit is far better on the basis of the assumed gametic ratio than the normal one, although the latter also holds good, as the value of Dev./P. E. shows.

The result obtained in the fourth generation which is shown in Table 6 indicates that the proportion of K and k gametes appears to be still closer to 1 : 1 proportion than before. In the total of 100 families shown, the proportion of KK and Kk families agrees very closely with that calculated on the basis of a gametic ratio 1.1 : 0.9 or 55 : 45 per cent. See Table 7.

TABLE 7

	No. of families		Total	Deviation	Dev./P. E.
	KK	Kk			
Observed	38	62	100		
Cal. (1.1)	33.3	66.7	100	±4.7	1.5
Cal. (1.1 : 0.9)	77.9	62.1	100	±0.1	0.03

Summarizing the assumed gametic proportions from the first to the last generations thus far discussed, they are as follows:

TABLE 8*

Year	$K:k$ per 2	Percentage	Difference (%)
1921	2.00 : 0	100 : 0	16
1922	1.68 : 0.32	84 : 16	12
1923	1.24 : 0.76	62 : 38	7
1924	1.10 : 0.90	55 : 45	5
—	1.00 : 1.00 (normal)	50 : 50	

* Compare fig. 2.

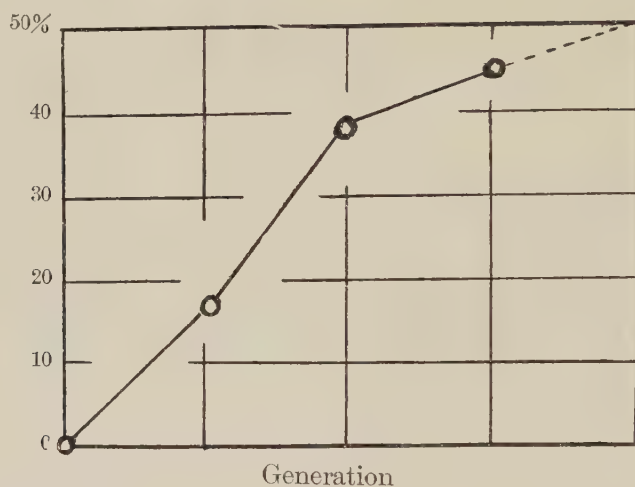


Fig. 2. Graph showing the hypothetical percentage proportion of mutated and unmutated gametes in terms of mutated gametes.

III. Reversional Formation of Dwarfs

As already stated, the roll-leaved fertile mutants (NK) have been discovered among the progenies of the plants which was heterozygous for dwarf factor. But the strain which is homozygous for the factor for the normal stature has been kept for the further experiment. In 1919 the dwarf plants however reappeared in 10 out of 211 families in the following numbers.

TABLE 9

Pedigree	Normal stature	Dwarf	Total	Per cent dwarf
'18-29	90	9	99	9.09
2	38	6	44	13.64
9	94	4	98	4.08
10	84	9	93	9.68
11	93	3	96	3.12
12	99	1	100	1.00
14	92	4	96	3.12
?- 48	81	1	82	1.22
-29- 20	97	3	100	3.00
-44-207	91	7	98	7.14
Total	859	47	906	M=5.51

The pedigree shows that seven out of ten families in which the dwarfs have been discovered are the offspring of the family No. 29 of the previous year, and three others are those of the different strains. The family No. 29 was homozygous for the normal-leaf factor but heterozygous for the factor *B* which modifies the mode of development of the awn. The segregation was shown to be monohybrid in respect to full- and medium-awned types. The offspring of this family were 20 in total, and 7 of them contained dwarfs as shown in Table 9.

In the dwarf type of rice there are many forms of more or less distinct characters. Thus for example we know both dominant and recessive dwarfs. SUGIMOTO (1923) reported the case in which both types arose by mutation in the pure lines and the fixed progeny derived from the hybrid. The recessive dwarf of mutative origin has been reported by PARNELL *et al* in India (1922).

The type of dwarf here concerned is recessive to normal. The offspring of the normal plants from family No. 29-7 produced in the next year 29 constant and 55 dwarf-throwing families. The number of dwarf plants in these families however showed a marked deviation from each other. The percentage of dwarfs differs from 2 to as much as 35,

but in the sum of all these families, the ratio of normals to dwarfs is nearly 3 to 1. Thus

TABLE 10

	Normal	Dwarf	Total
Observed	2579	628	3207
Expected (3:1)	2405.25	801.75	
Deviation	173.75	173.75	

TABLE 11

% dwarfs	1	5	10	15	20	25	30	35	40	Total
No. of families	2	0	11	15	12	12	2	1		55
Mean % dwarf	19.77									

On examining the foregoing data, we see that the quantitative relation of mutant and normal plants is quite similar to the case of compact-panicked mutants. Supposing that the number of the gametes D and d which represent the factors for normal and dwarf stature respectively, formed by the normal plant at first, was very uneven as in the former case, the random mating would give the zygotes of different kinds in the following proportions, provided the gametic proportion be $D:d=80:20$ per cent, then $DD=64.0$, $Dd=32.0$, $dd=4.0$ per cent.

The observed mean percentage of dwarfs in the total of seven progenies of family No. 29, was 5.75. We observed that 13 other families out of 20 were constant normals, hence the proportion of constant and mutant-throwing families is 65:35 per cent. On the basis of the above gametic ratio, 66.7 and 33.3 per cent are expected, therefore the deviation is 1.7.

Assuming further that in the next generation the proportion of functional D and d gametes becomes much closer to 1:1 than in the previous and supposing that the proportion of D and d is 1.11:0.89 or 55.5:44.5%, then the calculated numbers of plant and family agree closely with the observed ones. (S. Table 12).

TABLE 12 (compare Table 10.)

	Normal	Dwarf	Total
Observed	2579	628	3207
Calculated	2573.63	633.38	
Deviation	5.38	5.38	

The ratio of DD and Dd should then be 1.11×1.11 to 2 (1.11×0.89) hence the expected family numbers are 29.06 to 54.94 respectively and we have found 29 and 55, the deviation being 0.06 as contrasted to 28 and 56, with the deviation 1.0 which is required by the normal gametic ratio.

Thus in two cases of mutations just described, the increase of proportions of mutant individuals produced in the successive generations corresponds to the assumed gametic proportion which appears to shift from the uneven to the equal proportion, and by means of which the normal monohybrid Mendelian segregation may be realized.

Summary

A new type of completely sterile mutant, *awned sterile* has been described. Sterility is due to complete sterility of male gametes, the eggs being functional.

The mutated factor is s which is responsible for sterility and the unmutated factor is S which is the complementary factor for the normal form.

Parthenocarpic development of caryopsis in the awned sterile plants has been observed. These caryopsis which reach the full size of the mature grain is devoid of the endosperm and the embryo, but simply filled with a clear liquid.

The compact-panicked mutant is described. It is recessive to normal form and the factors concerned can be represented by k and K respectively.

Both of the mutant characters, awned sterile and compact-panicked are inherited independently from staminoidal sterile (roll-leaved) character.

A case of reversional production of dwarf plants from the constant roll-leaved fertile plants is reported.

The cases of compact-panicled mutant and the reverted dwarf mutant are peculiar in the mode of their inheritance. At first the number of mutants which appear is very small and in the next generation of the normal individual, the proportion of mutant individuals increased. The number of families in which the mutants appear were also found to increase.

There exists a definite quantitative relation between the number of mutants which have appeared and that of families which will throw the mutants in the next generation. The calculation based on the supposition of random mating of a certain unequal proportion of mutated and unmutated gametes agrees closely with the observation.

The gradual increase of mutant individuals in the subsequent generations indicates the corresponding increase of the number of mutated gametes. Thus the ratio of the number of mutated and unmutated gametes is changing from generation to generation, and the tendency of this change is towards the equality of the number of both kinds of gametes, in other words, the ordinary Mendelian segregation.

The writer wishes to express his thanks to Messrs. T. NIBE and G. INADUKA for kind assistance.

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Studies on the Mutations in *Oryza sativa* L.

III. On Paleaceous Sterile Mutant

By Isaburo NAGAI

With 5 Text-figures

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I. Origin, the Factors affected, and the Relationship to Other Characters

Paleaceous sterile mutant appeared in family No. 93-35-1-51, one of the progenies of the mutant family *NK* which has already been reported in the previous paper (NAGAI 1926, p. 25 ff.). The spikelets of this mutant form are abortive and a number of small, supernumerary green paleas are formed within the regular paleas (s. figs. 1-5) which are narrow and awnless like those of the staminoidal steriles. The anthers and ovules are seldom formed but generally abortive. Consequently the mutants are completely sterile in both sexes.

TABLE 1

Pedigree	Segregation	
1918 <i>NK</i> -93	$\begin{array}{ccc} & \text{N}^* & \\ & \text{---} & \\ & \text{3} & \end{array}$	
93-35		
93-35-1	$\begin{array}{ccc} & \text{N}^* & \\ & \text{---} & \\ & \text{3} & \end{array}$	
93-35-1-46	$\begin{array}{ccc} & \text{N}^* & \\ & \text{---} & \\ & \text{3} & \end{array}$	
-48	$\begin{array}{ccc} & \text{N}^* & \\ & \text{---} & \\ & \text{3} & \end{array}$	
-49	$\begin{array}{ccc} & \text{N}^* & \\ & \text{---} & \\ & \text{3} & \end{array}$	
-50	$\begin{array}{ccc} & \text{N}^* & \\ & \text{---} & \\ & \text{3} & \end{array}$	
-53	$\begin{array}{ccc} & \text{N}^* & \\ & \text{---} & \\ & \text{3} & \end{array}$	
-47	$\begin{array}{ccc} & \text{N}^* & \\ & \text{---} & \\ & \text{3} & \end{array}$	
-51	$\begin{array}{ccc} & \text{N}^* & \\ & \text{---} & \\ & \text{3} & \end{array}$	
-52	$\begin{array}{ccc} & \text{N}^* & \\ & \text{---} & \\ & \text{3} & \end{array}$	
-54	$\begin{array}{ccc} & \text{N}^* & \\ & \text{---} & \\ & \text{3} & \end{array}$	

* N=normal-leaved plants

* n=roll-leaved plants

The pedigree shows that the family No. 93-35-1-51 was one of nine offspring of the roll-leaved plants (slightly sterile). Of the remaining eight families, four were constant in respect to the leaf character, and the other four were mixed with a small number of normal-leaved plants. But none of these families contained any paleaceous sterile individual. For the pedigree and the record of families above stated s. Table 1, p. 67 and also Table 2, p. 72.



Text-fig. 1-5. Showing the abnormal structure of some of the spikelets of paleaceous sterile mutant. In each figure parts of each spikelet are taken out and arranged according to their order in it.

The family No. 93-35-1-51 was a peculiar one, owing to the fact that it contains not only the paleaceous sterile plants but also a large number of normal-leaved ones. We have 56 normal-leaved and 43 roll-leaved plants and most of these normals are homozygous and breed true. In respect to fertility the population of this mutant family consists of three kinds, namely, fertiles 35, partial steriles 36, and paleaceous steriles 17. A larger number of individuals are entered in the count respecting the character of leaf than respecting that of fertility, hence the individual numbers of the two counts do not agree. (Compare Tables 1 and 2). The offspring of fertile and partial steriles reared in 1922 gave the following groups of families.

1. Offspring of normal-leaved plants

(a) Offspring of fertiles	29 families without paleaceous steriles
(b) " " "	3 families segregating out paleaceous steriles
(c) Offspring of partial steriles	3 families without paleaceous sterile
(d) " " " "	1 family segregating out paleaceous steriles

2. Offspring of roll-leaved plants

- (a) Offspring of low partial steriles 11 families without paleaceous steriles
- (b) „ „ „ „ „ 18 families segregating out paleaceous steriles

It is evident from the family and plant ratios which will be shown presently that in the offspring of roll-leaved plants the paleaceous sterile is recessive to normal. In the offspring of heterozygous normal-leaved plants, practically none of the roll-leaved plants is paleaceous, so that the linkage of paleaceous sterile and normal-leaved characters is nearly complete. Thus three forms i. e., normal-leaved fertiles, normal-leaved paleaceous steriles and roll-leaved fertiles (slightly sterile) segregate out in a 2:1:1 ratio.

The normal-leaved fertile can be represented by the factors NG and roll-leaved fertile (slightly sterile) by $n'G$ where G is the complementary factor for the normal spikelets, and g its recessive allelomorph representing the paleaceous sterile.

It is assumed that G has no effect in the absence of N and n' . Thus

NG	normal-leaved fertile
$n'G$	roll-leaved fertile
Ng	normal-leaved paleaceous sterile
$n'g$	roll-leaved paleaceous sterile.

The heterozygous normals which throw three forms i. e., NG , Ng , and $n'G$ in a 2:1:1 ratio should be $\frac{Ng}{n'G}$. If we assume that there occurs no crossover between the pair of the chromosomes concerned, the gametes produced would be of two kinds, NG and $n'G$ and selfing would produce $\frac{Ng}{n'G}$, $\frac{Ng}{NG}$ and $\frac{n'G}{n'G}$ in a 2:1:1 ratio.

Further complication has been brought about in one of the segregating families which are the offspring of the normal-leaved plants: Family 93-35-1-51-2-s produced normal-leaved fertile, normal-leaved paleaceous sterile, and roll-leaved staminoidal sterile, i. e., NG , Ng and nG in a 2:1:1 ratio. They must have been produced by the heterozygous individual $\frac{Ng}{nG}$ instead of $\frac{Ng}{n'G}$.

As already stated, the majority of normal-leaved plants gave constant progenies, hence they must be homozygous NG .

Remembering the fact that all of these families are derived from a single roll-leaved plant $\frac{n' G}{n' G}$, the whole change must be interpreted to have originated by the complex vegetative mutations of the rarest occurrence. The original plant may therefore be assumed to be a complex chimera constituted by three sectors, (A) $\frac{N G}{N G}$, (B) $\frac{n' g}{n' G}$, and (C) $\frac{N g}{n' G}$ due to mutations occurring in the vegetative cells of the plant $\frac{N G}{N G}$ at an early stage of its development. The sector (B) occupies the largest portion, the sector (A) the next larger, and the sector (C) a very small portion of the whole tissue which gives rise to the gametic cells.

The sector (A) might have arisen from a single cell in which the mutation from n' to N occurred in both members of the diploid chromosomes ($\frac{*}{*}$),⁽¹⁾ whereas (B) from another cell in which the factor G mutated to g at one of the homologous pair, ($\frac{*}{*}$). The case of (C) involves two different factors or loci n and G but on the same chromosome ($\frac{*}{*}$). The chances of the occurrence of such mutations must be very scarce and in fact we have found only a very small number of families which are to be regarded as originated from the sector (C).

It is very likely that the sector (A) $\frac{N G}{N G}$ has been brought about by two successive mutations in every other member of the homologous pair, namely from $\frac{n' G}{n' G}$ to $\frac{N G}{n' G}$ and then to $\frac{N G}{N G}$. Contrary to the expectation, the heterozygous individuals were found to be very small as compared with the homozygous ones.

The zygote with the constitution $\frac{N g}{n G}$ which has given rise to the staminoidal steriles and the normal fertiles would have been resulted by the changes in three loci, ($\frac{*}{*}$) but such changes are most unlikely to occur. It might have arisen from the mutated cell, $\frac{N g}{n' G}$ (sector C) by further mutation at the locus of the other member of the chromosome pair. There was only one such family corresponding to this category.

Unfortunately the record of leaf character of paleaceous plants of the original family (93-35-1-51) was incomplete, yet the approximate size of each sector can be estimated from the data obtained in the following

(1) Lines indicate the homologous chromosomes and the cross marks the loci.

two generations. The number of harvested plants were 88 (17 were sterile) and 65 of them were tested in 1922 as already mentioned.

Each sector of the original plant which gave rise to family 93-35-1-51 would produce the progenies as shown below:

Sector	Zygote	Genotype	Phenotype	Obs.	Calc.
$\frac{n' G}{n' G}$	B	$b_1 = \frac{n' g}{n' g}$	Roll-leaved, paleaceous sterile—	(9.0)	36
		$b_2 = \frac{n' g}{n' G}$	„ „ partially sterile	18 18.0	
		$b_3 = \frac{n' G}{n' G}$	„ „ „ „	11 9.0	
	C	$c_1 = \frac{n' G}{n' G}$	„ „ „ „	2.0	8
		$c_2 = \frac{Ng}{n' G}$	Lf. normal fertile	1 ^{(1)*}	
		$\left(\frac{Ng}{n' G}\right)$	„ „ „	1 ⁽²⁾	
			„ „ „	1 ⁽³⁾	
			„ „ partially sterile	1 ⁽⁴⁾	
		$c_3 = \frac{Ng}{Ng}$	Lf. normal paleaceous sterile	— (2.0)	
	A	$a = \frac{NG}{NG}$	Lf. normal, partially sterile	3	32
			Lf. normal fertile	29	

* Family No. $\left\{ \begin{array}{l} (1) \text{ 93-35-1-51-10} \\ (2) \text{ „ „ „ „ -19} \\ (3) \text{ „ „ „ „ -20} \\ (4) \text{ „ „ „ „ - 2.-8.} \end{array} \right.$

If our assumption be correct, the number of paleaceous sterile plants will be the sum of b_1 and c_3 which should correspond to the number of homozygous roll-leaved fertiles ($b_3 + c_1$). There were 11 such families, and at the same time we had 4 heterozygous, normal-leaved plants (c_2) which should be twice as many as c_3 (normal-leaved, paleaceous sterile). Hence we assume that those 11 constant, roll-leaved families are derived from B sector (9 out of 11) and from C sector (2 of the rest). Agreement of observed and calculated numbers of families is fairly close as shown above. Accordingly, the number of roll-leaved and normal-leaved plants of the original family, No. 93-35-1-51 should be equal, and in fact there were 56 normal and 43 roll-leaved plants, where 49.5 with Dev./P. E. = 1.97 is expected. The proportion of three sectors expressed by the seeds produced would therefore be A : B : C = 42.1 : 47.4 : 10.5 per cent.

The recent papers of NILSSON-EHLE (1920, 1921) and of ÅKERMAN

(1920) on the speltoid mutants of wheat may be referred here. In that case many characters have been affected at once by a "complex mutation." The latter author found among the progenies of the common wheat, a mosaic plant which possessed the characters of both speltoid and common wheat. The present case in rice, together with other mutations elsewhere discussed are in many respects analogous to those which have been observed in wheat.

Table 2 gives the result of an examination of the forms of spikelets borne on the plants, taken from the different families which are derived from the family No. 93-35-1. It may be borne in mind that the paleaceous sterile mutant has been discovered in one of these families (see Table 1). Most of the spikelets are normal but some with the mutant characters are found scattered in the panicles of the individual plants. Of these, a small number are staminoidal (0.36 per cent) and a still smaller number are paleaceous (0.06 per cent), exclusive of the family No. 93-35-1-51 in which the latter character is manifested by almost all the spikelets of the plant. These exceptional spikelets represent

TABLE 2
Twenty spikelets from each plant taken at random.

Pedigree	No. of plants examined	Kind of spikelets				Total
		Staminody	Super-numeral ovules	Paleaceous	Normal	
93-35-1-46	19	5	2	1	372	380
-47	42	2	14	0	824	840
-48	22	3	5	0	432	440
-49	23	1	0	0	459	460
-50	25	4	2	0	494	500
-51	42	0	5	203	632	840
-52	21	3	2	1	454	460
-53	29	0	5	1	574	580
-54	24	0	2	0	478	480
Total	247	18	37	206	4719	4980
Per cent	:	0.36	0.74	4.14	94.76	

the mutants within the single individual expressed by the spikelets as an unit, otherwise shown by the whole panicles of the plant. Together with these spikelets, the mosaic plants which have often been observed in the progenies of the heterozygous normal plants elsewhere stated, serve to show that the condition of the plant constitution caused by the mutative instability, is such that the segregation of factors frequently occurs in the somatic cells of the individual plants.

II. Offspring of Normal-leaved Plants

As already stated (s. p. 68) there were 36 families derived from the normal-leaved plants. Five of them were the offspring of partially sterile plants. Three of the latter were constant in respect to fertility and the leaf character, except few anomalous individuals. Two of the rest of five families were heterozygous, segregating out the normals and the paleaceous sterile mutants. Other 29 from the normal fertiles were constant.

A. OFFSPRING OF PARTIALLY STERILE PLANTS

The segregation of family No. 93-35-1-51-2-s observed in 1922 was as follows:—

TABLE 3

	Normal-leaved, non paleaceous	Normal-leaved, paleaceous sterile	Roll-leaved, staminoidal	Roll-leaved, paleaceous
Observed	44	18	19	0
Expected (2 : 1 : 1)	40.25	20.25	20.25	
Deviation	+3.5	-2.25	-1.25	

The heterozygous plant $\frac{Ng}{nG}$ will produce two kinds of gametes Ng and nG when there occurs no crossover between the homologous chromosomes which carry factors Ng and nG respectively. The zygotes produced will be of three kinds, $\frac{Ng}{Ng}$, $\frac{nG}{nG}$ and $\frac{Ng}{nG}$ where the first two are steriles. The former of the first two is normal-leaved paleaceous sterile and the latter roll-leaved staminoidal sterile. All the normal-leaved non-paleaceous (partially sterile) should be heterozygous and were proven to be the case. See Table 4.

TABLE 4

Family no.	Normal-leaved			Roll-leaved		Mosaic-leaved
	non paleaceous low P. S.*	P. S.	sterile	paleaceous	staminoidal	P. S.
1	63	1		24	27	
2	61	—		37	21	
3	56	2		40	28	
4	64	—		32	25	
5	47	—		21	22	
6	54	1		30	24	
7	67	2	1	25	25	
8	50	2		22	26	1
9	62	1		35	24	
10	56	2		26	26	
11	58	3		27	28	
12	61	1		24	23	
13	52	—		34	25	
14	62	—		29	17	
15	50	—		39	19	
16	60	—		36	19	
17	57	—		34	24	
18	61	1		28	24	
19	32	—		11	16	
20	15	—		16	10	
21	61	—		31	15	
22	52	—		38	21	
23	43	—		21	15	
24	51	—		35	21	
25	57	—		28	21	
26	53	3		44	14	
27	49	—		28	28	
28	46	2		29	24	
29	49	—		27	33	
30	57	—		27	26	
31	58	3		27	21	
32	4	—		6	2	
33	48	—		20	22	
34	47	—		20	16	
Total	1763	24	1	941	732	1
Per cent Expected	1788 51.66 1730.50			27.19 865.25	21.15 865.25	

* P. S.=partially sterile.

As shown in Table 4, the number of staminoidal steriles is deficient as usual. In the total of all the families, the percentage is 21.14, being therefore 3.86 more deficient than in the normal case. Among the normal-leaved plants, the ratio of non-paleaceous and paleaceous steriles is nearly 2:1. There are 1788 and 941 where 1819.33 and 909.67 are required, the deviation being 31.33.

The partial sterility of the normal-leaved plants is on the average 26%.

B. OFFSPRING OF FERTILE PLANTS

In the family No. 93-35-1-51-10 the proportion of three forms, i. e., normal-leaved fertile, normal-leaved paleaceous sterile and roll-leaved partial sterile conformed also to a non-crossover ratio. (S. Table 5).

TABLE 5

	Normal-leaved fertile paleaceous		Roll-leaved partially sterile	Total
Observed	52	26	29	107
Calc. (2:1:1)	53.5	26.75	26.75	
Deviation	-1.5	-0.75	+2.25	

The offspring of 38 normal-leaved fertiles gave in the next year exactly the same sort of segregation as in the previous one, except one family No. 93-35-1-51-2-s. (S. Table 6). The offspring of 16 roll-leaved plants were constant in respect to fertility. Anomalous normal-leaved plants were also found in small numbers together with the mosaic plants in which both normal and rolled leaves are formed. (S. Table 7).

TABLE 6

Sum of 37 families

	Normal-leaved fertile P.S. paleaceous			Roll-leaved slightly sterile	Roll-leaved fertile P.S.		Total
Observed	1462	7	720	621	2	1	2813
Expected	1405		702.5	702.5			
Deviation	+57		+17.5	-81.5			

TABLE 7

Sum of 16 families, offspring of roll-leaved plants

Normal-leaved, non paleaceous (anomalous)	Roll-leaved non paleaceous	Mosaic-leaved	Total
29 2.23 %	1298	2	1329

Thus all the families from the normal-leaved fertiles and from the partial steriles, except the family No. 5 are shown to be derived from the $\frac{Ng}{n'G}$ individuals. This exceptional family gave the following segregation, and is apparently derived from the $\frac{Ng}{nG}$ plant. (S. Table 8).

TABLE 8

Normal-leaved		Roll-leaved		Mosaic-leaved	Total
non paleaceous	paleaceous sterile	non paleaceous	staminoidal sterile		
44	26	7	17	1	91

In the following two families namely, No. 93-35-1-51-19 and No. 93-35-1-51-20 s, the roll-leaved, paleaceous sterile plants have appeared, so it is evident that the crossover has occurred between the loci N and G . The percentage of crossover may be guessed somewhere at 16 to 17 as suggested by the segregating ratio shown below.

TABLE 9

Family No.	Normal-leaved			Roll-leaved			Mosaic- leaved
	fertile	partial- sterile	paleaceous sterile	partial- sterile	sterile	paleaceous sterile	
No. 19	39	0	20	36	0	8	0
No. 20	37	9	18	22	1	1	1
Total	85		38	59		9	
Per cent	44.50		19.90	30.89		4.71	

The progenies reared in the next year however showed an unexpected result. None of the offspring of normal-leaved plants from the family No. 93-35-1-51-19 and nearly none of them from the family No. 93-35-1-51-20-s gave the non-crossover or 2:1:1 ratio.

In the progeny of No. 93-35-1-51-19 there were 26 families from the normal-leaved plants and 24 from the roll-leaved plants. Of the latter, 7 were constant roll-leaved, non paleaceous $\frac{n' G}{n' G}$ and 17 were heterozygous $\frac{n' G}{n' g}$ segregating roll-leaved fertile (slightly sterile) and roll-leaved paleaceous steriles in a 3:1 ratio. This will indicate that the parental roll-leaved plant was heterozygous.

If the segregating ratio of the previous year was true, we should not expect such a result, but granting that the observed ratio of the previous year were incorrect due to unexpected experimental error, and that a non-crossover ratio were the case, we should still expect that all the progenies of the roll-leaved plants be constant. No satisfactory answer can be offered at present. (See Table 11 B).

Equally peculiar was the segregation shown by the offspring of family No. 93-35-1-51-20-s in which the following groups of families were present (compare Table 11 A).

(A) Progenies of fertile plants (normal-leaved)

- (a) 29 families showing non-crossover ratio, segregating both in respect to leaf and palea characters.
- (b) 2 families showing a 3:1 ratio segregating in respect to the leaf character only ($NG:n'G$).
- (c) a single family showing a 3:1 ratio segregating into normal-leaved fertile and roll-leaved paleaceous steriles ($NG:n'g$).

(B) Progenies of partially sterile plants (normal-leaved)

- (d) 3 families showing the segregation of non-crossover ratio but apparently deviating from the normal 2:1:1 ratio.
- (e) 3 families constant in the leaf and palea characters.

As these families indicate, the majority of the offspring of normal-leaved plants are heterozygous and non-crossovers, but still it can be seen that the rest of them are apparently derived from the union of the crossover gametes, NG and $n'g$. If the crossovers were very small in number as compared with non-crossovers, we might expect to have a small number of families grouped under (b) and (e), but those of (c) are not expected to occur at all. It may be seen therefore that the

crossovers had occurred once in the grand-parental plant, giving rise to family 93-35-1-51-20-s. But in the heterozygous normal-leaved plants thus produced, no more crossovers occurred at the time of gametogenesis, hence the majority of the normal-leaved plants, even when they are heterozygous $\frac{N g}{n' G}$, produced nothing but non-crossovers. And a very small number of heterozygous normals of the constitution $\frac{N G}{n' g}$ which have resulted from the crossover gametes in the foregoing generation would give rise to the family of group (c). In that family, normal-leaved fertile ($N G$) and roll-leaved paleaceous sterile ($n' g$) appear in a 3:1 ratio. Recently IKENO (1924) has observed in *Portulaca* that the crossovers occurred in the third generation of certain progenies of the cross between the forms of different flower colours, but up to the second generation no crossovers appeared to have taken place. The present case seems to be just the reverse of that of *Portulaca*, though the observed numbers are too small to give a definite conclusion.

The crossover in one sex only would also give a 2:1:1 ratio like the non-crossovers but it is very unlikely that we have to deal with the sex linkage in the present instance.

The offspring of roll-leaved plants were shown to be homozygous for $n' G$. This is what we might expect since the number of non crossovers would be large as compared with crossovers, hence the heterozygous individuals would not appear in the small sample as we have dealt with.

Another fact to be noted is the offspring of normal-leaved partially sterile plants in which the proportion of normal and roll-leaved plants is decidedly different from that shown by the offspring of the fertile individuals. In the former the roll-leaved plants are over 50 per cent of the total where 25 per cent is required on the basis of the normal ratio. Also it may be noted that the constant normal-leaved families are found to occur only in the offspring of the partially sterile plants. Compare Table 11 A.

TABLE 10

Progenies of 93-35-1-51-19 (compare 11 B)

(A) Offspring of normal-leaved plants. Sum of 26 families

	Normal-leaved		Roll-leaved	Mosaic-leaved		Total
	non paleaceous	paleaceous sterile	non paleaceous	paleaceous sterile	non paleaceous	
Obs.	1445	734	653	0	4	1391
Expect. (2:1:1)	1416	708	708			
Dev.	+29	+26	-55			

(B) Offspring of roll-leaved plants. Sum of 7 families

	Normal-leaved		Roll-leaved		Mosaic-leaved		Total
	non paleaceous	paleaceous sterile	non paleaceous	paleaceous sterile	non paleaceous	paleaceous sterile	
Obs.	41	18	496	144	2	3	704
Expect. (3:1)	(anomalous)		480	160			
Dev.			+16	-16			

(C) Offspring of roll-leaved plants. Sum of 17 families

Normal-leaved		Roll-leaved		Mosaic-leaved		Total
non paleaceous	paleaceous sterile	non paleaceous	paleaceous sterile	non paleaceous	paleaceous sterile	
(anomalous)						
22	0	1675	0	7	0	1704

TABLE 11 A

Progenies of 93-35-1-51-20-s

Abbreviations N. L. = normal-leaved R. L. = roll-leaved F. = fertile

P. S. = partial sterile P. L. S. = paleaceous sterile

S. = complete sterile

1923 Family number	Parent	N. L.				R. L.				Mosaic. F.	Total
		F.	P. S.	S.	P. L. S.	Low P. S.	P. S.	S.	P. L. S.		
1	N. L. F.	54	1		29	24	2				114
2		43			13	14	3			3	73
3		53	3		34	20	5				115
4		51			38	14	6				109
5		59			26	24	4				113
6		43			15	18	1	1			78
7		71			21	17	2				111
8		6			2	4	1				13
9		49			34	30	3				117
10		60			30	18	5				113
11		52	2		30	26	3	1			113
12		57			31	29	—			1	112
13		45	1		38	28	3				115
14		64			32	18	3				117
15		45			28	18	5				96
16		57			30	28	—				115
17		49			40	27	2	1			119
18		66	2		29	25	—				122
19		63			20	24	3	1			111
21		63			32	23	2				120
22		58			23	18	3	1		2	103
24		53			18	19	—	1			91
25		36			21	13	5				75
26		51	1		25	23	—	1			101
27		62			28	22	3				115
28		55			37	24	1				117
29		63			29	13	3				108
31		56			31	17	11				115
32		56			32	25	5				118
35	N. L. P. S.	49			31	22	1				103
36	"	25			22	52	1	1		1	105
38	"	17	2		6	20	4				50
23	N. L. F.	65				26	—				91
30	"	93				22	—				115
33	N. L. P. S.	50	18	1		—	—				69
34	"	98	12	2		—	—				112
37	"	41	5			—	1				47
20	N. L. F.	80	1			—	—	—	23		113
39	R. L.					20	3	4			27
40						85	8	1			94
41						39	19				58
42						9	5				14
43						85	8				93
45			1			41	2			1	44
45			1			25	4				30
46			2			67	20			1	90

TABLE 11 B

Progenies of 93-35-1-51-19

Family no.	Parent	N. L.			R. L.					Mosaic.	
		F.	P. S.	P. L. S.	Low	P. S.	P. S.	S.	P. L. S.	F.	P. L. S.
1	N. L.	68	—	27	33	1	—	—	—	—	—
2		26	—	26	15	2	—	—	—	—	—
3		23	1	16	17	—	—	—	—	—	—
4		73	—	31	30	—	1	—	—	—	—
5		46	—	25	15	1	—	—	—	—	—
6		56	—	39	23	—	1	—	—	—	—
7		67	—	30	34	2	—	—	—	1	—
8		53	—	22	21	—	—	—	—	—	—
9		77	1	30	23	4	—	—	—	3	—
10		48	2	28	21	—	1	—	—	—	—
11		49	—	23	20	1	1	—	—	—	—
12		60	—	30	18	—	1	—	—	—	—
13		54	—	39	25	1	1	—	—	—	—
14		57	1	37	30	1	—	—	—	—	—
15		32	—	13	17	2	—	—	—	—	—
16		72	—	28	32	—	—	—	—	—	—
17		46	—	26	23	2	—	—	—	—	—
18		45	—	21	18	1	—	—	—	—	—
19		92	—	40	27	—	2	—	—	—	—
20		54	—	22	26	—	—	—	—	—	—
21		20	2	9	7	2	—	—	—	—	—
22		55	1	34	31	—	1	—	—	—	—
23		60	—	48	38	1	1	—	—	—	—
24		58	1	24	26	—	—	—	—	—	—
25		95	—	42	30	4	—	—	—	—	—
27		49	1	24	17	1	—	—	—	—	—
29	R. L.	9	1	1	62	8	3	12	—	—	—
33		8	—	2	66	10	—	32	—	—	—
38		3	—	7	94	20	—	32	—	—	—
44		10	—	3	72	8	6	25	—	1	1
45		4	—	4	30	11	9	10	—	1	2
46		—	—	—	15	3	12	14	—	—	—
49		6	—	1	59	3	5	19	—	—	—
26		5	—	—	80	3	2	—	—	—	—
28		2	—	—	121	6	1	—	—	—	—
30		—	—	—	101	12	—	—	—	1	—
31		2	1	—	48	10	—	—	—	—	—
32		—	—	—	45	16	3	—	—	—	—
34		—	—	—	63	8	32	—	—	—	—
35		1	—	—	64	21	2	—	—	—	—
36		3	—	—	92	7	2	—	—	—	—
37		2	—	—	94	18	1	—	—	—	—
39		1	—	—	115	17	1	—	—	1	—
40		—	—	—	41	15	1	—	—	—	—
41		1	—	—	60	12	—	—	—	—	2
42		—	—	—	70	11	2	—	—	—	—
43		2	—	—	129	9	1	—	—	—	—
48		—	—	—	117	11	5	—	—	—	—
50		1	—	—	106	8	—	—	—	—	—

III. Offspring of Roll-leaved Plants

There were 31 roll-leaved plants in the harvested population of the original mutant family (93-35-1-51) and 29 of them were tested in 1922. We found that 18 of them were heterozygous segregating out the paleaceous steriles, and 11 were constant, nevertheless having few anomalous normal-leaved plants with fertile and partially sterile panicles. On the basis of a 1:2 ratio we should expect out of 29 families, 9.67 and 18.33 where we observed 11 and 18, the deviation being therefore 0.33. (S. Table 12).

TABLE 12

A. Sum of 11 families (constant)

Roll-leaved		Roll-leaved	Normal-leaved			Mosaic-leaved		
	partial sterile and sterile	paleaceous sterile	fertile	P. S.	palea- ceous	fertile	P. S.	palea- ceous
Observed	274	0	2	11 (anomalous)	0	0	0	0

B. Sum of 18 families (segregating)

Observed	484	124	31	12	29	2	1	2
Expected	456	152	(anomalous)					
Deviation	+28	-28						

A further test was carried out in the following generation. The result was essentially the same as in the previous year. Thus in the family No. 93-35-1-51-17 which was the offspring of roll-leaved and low partially sterile plants, we found 48 roll-leaved non paleaceous and 13 roll-leaved paleaceous ones, besides 10 anomalous normal-leaved and 2 mosaic individuals. The offspring of non-paleaceous plants reared in 1923 gave 23 segregating and 11 constant families. A close approximation to the expected 1:2 ratio is realised. In the sum of these two groups of families, we found the following result.

TABLE 13

A. Sum of 23 families heterozygous for *G*

Roll-leaved		Normal-leaved		Mosaic-leaved	
non paleaceous	paleaceous sterile	non palea- ceous	paleaceous sterile	non palea- ceous	paleaceous sterile
Obs. 1245	330	130	113	39	23
66.23%	17.55%	12.93%		3.30%	
Exp. 1181.25	393.75	(anomalous)			
Dev. +63.75	-63.75				

B. Sum of 6 families homozygous for *G*

Obs. 743	0	22	5	5	0
		2.84%	0.65%	0.65%	
		(anomalous)			

Almost every family contained a few anomalous normal-leaved individuals. These normal-leaved plants are heterozygous so far tested, segregating in a 2:1:1 ratio, as the regular heterozygous plants do.

Summary

A case of complex mutation in rice is reported. From a single homozygous roll-leaved fertile plant, a third type of completely sterile mutant, *paleaceous sterile* and the normal-leaved fertile mutant (reversion), both in homozygous and heterozygous conditions have appeared. The original plant was therefore a complex mosaic, having three sectants of different genetic compositions.

Paleaceous sterile is due to the factor *g* mutated from *G* which is the complementary factor for the normal form.

The factor *G* and *g* have no effect in the absence of *N* or *n'* which is the ground factor for the development of the normally fertile or slightly sterile form, thus the *nG*, *ng* plants are all alike staminoidal steriles.

Thus we have met with three forms of completely sterile mutants, and their genetic compositions are summarized as follows:

NGS	normal-leaved fertile
nGS	roll-leaved staminoidal sterile (egg sterile)
ngS	„ „ „
nGs	„ „ „
ngs	„ „ „
NgS	normal-leaved paleaceous sterile (sterile in both sexes)
$n'gS$	roll-leaved paleaceous sterile („ „ „ „)
NGs	normal-leaved awned sterile (pollen sterile)

Two pairs of factors $\frac{N}{n'}$ or $\frac{N}{n}$ and $\frac{G}{g}$ are apparently located in the same homologous chromosome pair, and usually no crossover takes place between the loci in which they are located. Thus in the offspring of the normal-leaved plants $\frac{Ng}{n'G}$, the paleaceous sterile and the roll-leaved characters repel each other, and in the offspring of the roll-leaved plants $\frac{n'g}{n'G}$, the paleaceous sterile behaves as a simple recessive to fertile.

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Studies on the Mutations in *Oryza sativa* L.

IV. On a Case of Partial Sterility

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It is well known that there occur a number of factors concerning the partial sterility in rice. To cite an example, TERA0 (1921) has found a case of semi-sterility where the semi-sterile plants always throw fertiles and semi-steriles in a 1:1 ratio, since the latter are always heterozygous owing to a sex-linked lethal factor.

The present case is another kind of partial sterility arising from the progenies of the mutant family *NK* which has already been reported in the previous paper (NAGAI 1926, p. 25ff.).

The normal-leaved plants in the progenies of the mutant family mentioned in the previous paper occasionally produce partially sterile plants. In these plants the sterile spikelets are scattered in all panicles of each plant or sometimes limited to its one or more particular panicles, or else sectorially distributed over certain portions of a panicle. This type of sterility differs from the complete sterility due to staminody, though few staminoidal flowers are found when examined at the early stage. Except the latter case spikelets which are empty when ripe show no abnormal morphological features at the early stage, so it is certain that all empty spikelets borne by the partially sterile plants are not due to staminody. It was further observed that the sterile spikelets of partially sterile plants have no linkage relation to the awn character, whereas the staminoidal steriles are completely awnless as elsewhere mentioned.

As already stated in the previous paper roll-leaved fertile plants are always slightly sterile as compared with normal-leaved fertile plants. The partial sterility manifested by the plants which arose from the normal-leaved fertile plants is much higher in its intensity than that manifested by the roll-leaved fertiles, nevertheless the highly sterile individuals have arisen also frequently from the latter.

The offspring of the partially sterile plants are generally partially sterile like their parents, but frequently throw fully fertile plants. Thus the change is reversible; it involves two categories, (1) accompanied by

the change in the leaf character, (2) without such change.

A. SERIES

NK No. 93 was one of the constant roll-leaved families derived from *NK* mutant in 1917. Two families No. 93-35 and No. 93-36 were selected for further investigation. The former was composed of 96 roll-leaved and 3 normal-leaved plants, and there were few plants which were more highly sterile than those usually found in the roll-leaved plants. The latter family was a constant leaved one. The progenies of slightly and highly sterile plants were as follows:

TABLE 1

Pedigree	Progenies
93-36-5	90 plants were all partially sterile of low grade.
-49*	{ 3 plants were completely sterile and awned. 2 plants were partially sterile of high grade.
93-35-48*	{ 2 plants were completely sterile. 4 plants were nearly completely sterile.
-45*	2 plants were completely sterile and awned.
-44	{ 2 plants were completely sterile. 20 plants were partially sterile of low grade.
-42*	{ 1 plant was normally fertile and normal-leaved. 4 plants were completely sterile and awned.

* highly sterile.

It can be seen therefore that the highly sterile plants tend to produce a larger number of highly sterile or completely sterile plants than those of low grade do.

The family No. 93-35-44 contained a single normal-leaved fertile plant. The offspring of this plant reared in 1921 showed that the latter was heterozygous for the factors for leaf and fertility. Other 19 sister families which were the offspring of low grade partial steriles bred true with few exceptional fertile plants. The segregation observed in the offspring of normal-leaved plant is as in Table 2, p. 87.

In the next year, there were planted 53 families from the normal-leaved fertile plants and 22 from the slightly sterile, roll-leaved plants. As the rollness of the leaf and the partial sterility of low grade are

TABLE 2

	Normal-leaved fertile	Roll-leaved, low partial sterile	Total
Observed	253	63	326
Expected (3:1)	244.5	81.5	
Deviation	18.5	18.5	
Dev./P. E.	3.51		

associated with each other, it is expected to have the constant normal-leaved fertile and the segregating families according to a 1:2 ratio in the offspring of fertile plants. On the contrary the majority of normal "constant" and segregating families were found to contain a small number of normal-leaved partially sterile plants.

Thus we have four kinds of families (see Table 3).

Constant normal-leaved families

- (a) fertile plants only.
- (b) fertile (98.6 per cent) and partially sterile plants (1.46 per cent).

Segregating families

- (c) normal-leaved fertile and roll-leaved partially sterile (low grade) plants in a 3:1 ratio.
- (d) normal-leaved (97.06 per cent fertile and 2.94 per cent partial sterile) and roll-leaved partial sterile plants (low grade) in a 3:1 ratio.

The mean percentage of normal-leaved partially sterile plants in (a) group is 1.46 per cent and in (d) group 2.94. In the total of constant normal-leaved families (a+b) and the segregating families (c+d), the percentages are 1.2 and 2.4 respectively. It shows that the heterozygous plants (Nn') produced twice as many normal-leaved, partially sterile plants as did the homozygous ones (NN).

The number of constant and segregating families are approximately in a 1:2 ratio. The observed numbers are 14 and 43 where 19 and 38 are required respectively. The deviation is 5 and Dev./P. E. 2.08.

B. SERIES

The pedigree cultures were started from the Family No. 93-35-1. As the pedigree number shows this family is derived from the plant belonging to the same family which gave rise to A series. As we have

TABLE 3

Pedigree	Parent	Normal-leaved			Roll-leaved			Total	P. S. %
		fertile	P. S.*	P. S. %	fertile	P. S.	P. S. %		
'22-1	N.L.F.*	95	4	4.04	—	—	—	99	4.04
3	"	103	2	1.90	—	—	—	105	1.90
6	"	105	1	0.94	—	—	—	106	0.94
9	"	99	1	1.00	—	—	—	100	1.00
12	"	103	1	0.96	—	—	—	104	0.96
18	"	98	2	2.00	—	—	—	100	2.00
19	"	102	2	1.92	—	—	—	104	1.92
20	"	103	1	0.96	—	—	—	104	0.96
26	"	99	1	1.00	—	—	—	100	1.00
38	"	100	1	0.91	—	—	—	101	0.91
44	"	98	1	1.01	—	—	—	99	1.01
47	"	99	1	1.00	—	—	—	100	1.00
4	"	105	—	0	—	—	—	105	0
29	"	102	—	0	—	—	—	102	0
2	"	78	—	0	—	25	100.0	103	24.27
5	"	76	—	0	—	27	"	103	26.21
7	"	86	—	0	—	19	"	105	18.10
22	"	88	—	0	—	15	"	103	14.56
23	"	83	—	0	—	21	"	104	20.19
24	"	77	—	0	—	24	"	101	23.76
33	"	98	—	0	—	1	"	99	1.01
36	"	81	—	0	—	20	"	101	19.80
8	"	61	7	10.29	—	36	"	104	41.35
10	"	75	3	3.85	—	26	"	104	27.88
11	"	70	6	7.89	—	30	"	106	33.96
13	"	77	2	2.53	—	26	"	105	26.67
14	"	82	2	2.38	—	20	"	104	21.15
15	"	69	7	9.21	—	26	"	102	32.35
16	"	68	3	4.23	—	30	"	101	32.67
17	"	81	1	1.22	—	22	"	104	22.12
21	"	79	5	5.95	—	19	"	103	23.30
25	"	63	7	10.00	—	31	"	101	37.62
27	"	72	1	1.37	—	34	"	107	32.71
28	"	79	1	1.25	—	26	"	106	25.47
30	"	80	1	1.23	—	24	"	105	23.81
31	"	74	1	1.33	—	29	"	104	28.85
32	"	71	2	2.74	—	29	"	102	30.39
34	"	80	1	1.23	—	18	"	99	19.18
35	"	83	1	1.19	—	18	"	102	18.63
37	"	72	1	1.37	—	29	"	102	29.41
39	"	71	1	1.39	—	28	"	100	29.00
40	"	67	5	6.94	—	26	"	98	31.63
41	"	84	1	1.18	—	17	"	102	17.65
42	"	81	1	1.22	—	18	"	100	19.00
43	"	73	2	2.67	—	23	"	98	25.51
45	"	78	1	1.27	—	25	"	104	25.00
46	"	76	1	1.30	—	21	"	98	22.45
48	"	83	1	1.19	—	20	"	104	20.19
49	"	82	3	3.53	—	21	"	106	22.64
50	"	72	1	1.37	—	28	"	101	28.43
51	"	83	1	1.19	—	230	"	107	23.36
52	"	85	1	1.16	—	19	"	105	19.05
53	"	78	2	2.50	—	24	"	104	25.00
54	"	66	2	2.94	—	37	"	105	37.14
55	"	82	2	2.38	—	22	"	106	22.64
56	"	82	1	1.20	—	19	"	102	19.61
57	"	60	2	3.23	—	40	"	102	41.18

* N.L.F.=Normal-leaved fertile

* P.S.=Partially sterile

already mentioned, family 93-35 which is the offspring of roll-leaved plant, contained three normal-leaved plants. The offspring of one of these normal-leaved plants has shown that the parental plant was heterozygous for the leaf factor. There were 60 full fertiles and 28 roll-leaved low partial steriles where 66 and 22 are required on a 3:1 ratio.

From these full fertiles 10 families were reared in the next year. Six of them were constant in respect to the leaf character but each of them contained a small number of partially sterile plants like the case with A Series. Otherwise these families are constant for both the leaf and fertility characters. Thus:

TABLE 4

Pedigree	Normal-leaved fertile	Normal-leaved part. sterile
93-35-1-36	58	4
-37	90	4
-40	85	2
-41	93	5
-43	57	4
-44	84	8
Total	472	27 (=5.4 %)

Besides, four other families segregated out normal and roll-leaved plants, and the mean percentage of partially sterile plants is 36.5. A marked excess of the latter from the expectation based on its being a monohybrid recessive is observed. This is largely due to one of these families in which the partially sterile plants were over 97 per cent of the total population. Discarding this family, the mean percentage of partially sterile plants is 30.2. The excess from 25 per cent is 5.2, thus corresponding to the percentage of normal-leaved sterile plants found in the constant normal-leaved families.

Two families No. 93-35-1-36 and No. 93-35-1-43 from the constant normal-leaved families were selected for further investigation. The offspring of the fertile plants from these families gave the following result.

TABLE 5

Pedigree	Normal-leaved		Total	% part. sterile
	fertile	partially sterile		
93-35-1-36	58	4	62	6.45
-43	57	4	61	6.56

In the next year 40 families from family No. 93-35-1-36 and 52 families from No. 93-35-1-43 were reared from the open fertilized seeds of the normal-leaved fertile plants. Most of them produced likewise a small number of partially sterile plants as in the previous generations. (S. Table 6).

TABLE 6

Offspring of	Number of families		Number of plants		
	with P. S.*	without P. S.	fertile	P. S.	% P. S.
93-35-1-36	32	8	4024	68	1.16
93-35-1-43	45	7	5883	96	1.61
Total	77	15	9907	164	
Mean					1.63

* P. S. refers to partially sterile plants.

TABLE 7

Pedigree	Normal-leaved		Roll-leaved		Mosaic plant
	fertile	P. S.	fertile	P. S.	
93-35-1-36-1-1 to 5	464	9	0	0	2
„ 36-2-1 to 5	253	6	0	0	0
„ 36-3-1 to 5	403	3	0	0	0
„ 36-4-1 to 5	391	0	0	0	0
„ 36-5-1 to 5	256	1	0	0	0
93-35-1-43-41-1 to 5	402	4	0	0	0
„ 43-42-1 to 5	393	1	0	0	0
„ 43-43-1 to 5	450	0	0	0	0
„ 43-44-1 to 5	443	1	0	0	0
„ 43-45-1 to 5	442	6	0	0	0
Total	3897	31 (0.79 %)	0	0	2

Further test has been carried out with the guarded seeds of the normal-leaved fertile plants. The result is shown in Table 7, p. 90. It can be seen that the percentage of partially sterile plants decreased to a considerable degree: their mean percentages in the successive four generations are 5.4, 6.5, 1.6 and 0.8 respectively.

It is now necessary to test the behavior of partially sterile plants which are thrown by the fully fertile plants. It has been found that they are constant like the fertiles from which they have arisen but these partially sterile individuals again throw few fully fertile plants. The offspring of partially sterile plants thrown by the normal-leaved fertile plants are as follows:

TABLE 8
Offspring of normal-leaved plants

Pedigree	Normal-leaved		Total	% fertiles
	fertile	P. S.		
93-35-36-1 to 3	13	294	307	4.24
93-35-1-43-34	5	102	107	4.67
Total	18	396	414	
Mean				4.35

These normally fertile plants produced by reversion throw again few partially sterile plants. (S. Table 9).

All the plants in Table 9 are reared from the guarded selfed seeds, hence accidental crossings are excluded. The family No. 93-35-1-36-4 is an exceptional one in which a large number of partial steriles are found. In the total of the rest of the families the percentage of reverted partially sterile plants is 46. It must be noted that all of these reverted individuals are not heterozygous but homozygous for the leaf factor *N*.

TABLE 9

Pedigree	Normal-leaved		Roll-leaved		Mosaic plant (leaf character)	Total
	fertile	P. S.	fertile	P. S.		
93-35-1-36-1-1	35					35
„ -2	30					30
„ -3	4					4
„ -4	14			16	1	31
„ -5	34					34
93-35-1-36-2-1	30					30
„ -2	40					40
„ -3	27	1				28
93-35-1-36-3-1	61					61
„ -2	97				1	98
„ -3	29	1				30
„ -4	31	1				32
93-35-1-43-34-1	95					95
„ -2	100					100
„ -3	34					34
„ -4	93					93
„ -5	92	1				93
Total	846	4		16	2	868
per cent		(0.46)		(1.84)	(0.23)	

C. SERIES

In B Series we have traced chiefly the behavior of normal-leaved, partial steriles of family No. 93-35-1. In this series, the progenies of roll-leaved plants are examined. As already stated, the family No. 93-35-1 segregated in respect to the leaf character and the offspring of three roll-leaved, slightly sterile plants gave few normal-leaved fertile plants. Thus:

TABLE 10

Pedigree	Normal-leaved		Roll-leaved		% normal-leaved fertile
	fertile	P.S.	fertile	P.S.*	
93-35-1-50	1	0	0	34	2.94
-52	3	0	0	54	5.56
-54	4	0	0	66	6.06
Total	8			154	
Mean					4.94

* Inclusive of all grades of partial steriles.

These normal-leaved, fertile plants were tested and it has been found that they are heterozygous for the leaf factor. See Table 11.

TABLE 11

Pedigree	Normal-leaved		Roll-leaved		Total
	fertile	P.S.	fertile	P.S.	
93-35-1-50-1	68		0	27	91
-52-2	68	3	0	21	92
-52-4	80		0	22	102
-54-5	87		0	17	104
-54-7	77	3	0	25	105
-54-8	79	1	0	24	104
Total	455	7	0	136	698
per cent	79.52	1.003		19.48	

In the next year a large number of plants from the guarded and unguarded seeds which are taken from the different plants have been tested. The results are summarized and given in Table 12. In this case the percentages of partially sterile plants produced by the homozygous and heterozygous individuals do not differ as contrasted to

the case of A series (compare Table 3). We have found also few normal-leaved fertile and partially sterile plants from the guarded seeds which are borne on the roll-leaved, partially sterile plants. In A series none of such "reverters" were found.

TABLE 12

A. Offspring of homozygotes NN								
Number of families	Seeds	Normal-leaved		Roll-leaved		Mosaic plant*	Total	% "revert."
		fertile	P. S.	fertile	P. S.			
17	guarded	344	2	0	0	0	346	0.58**
17	unguarded	462	5	0	0	0	467	1.07
B. Offspring of homozygotes Nn'								
28	guarded	1150	12	0	360	4	1526	0.786**
28	unguarded	1212	4	0	322	1	1539	0.260
C. Offspring of homozygotes $n'n'$								
9	guarded	6	1	0	473	2	482	1.24***
9	unguarded	1	0	0	396	4	401	0.24

* Normal- and roll-leaved.

** normal-leaved P. S.

*** Normal-leaved fertile and P. S.

Mention has already been made regarding the degree of partial sterility of normal-leaved and roll-leaved plants. The partially sterile plants arising from the normal-leaved plants are more highly sterile than the majority of the roll-leaved plants. But the latter also produce highly sterile individuals like those arising from the normal-leaved ones, and the rate with which these highly sterile plants are produced from the roll-leaved plants is greater than from the normal-leaved ones.

In the total of all the plants reared from the guarded seeds tested in 1923, the percentage of partial sterile plants is 7.0 to 14.75 in the roll-leaved plants, whereas in the normal-leaved plants, the percentages are 0.7 and 1.19 respectively in the offspring which are homozygous and heterozygous plants for the leaf factor.

On the other hand a roll-leaved highly sterile strain has been isolated in which the percentage of partially sterile plants reaches over 95 per cent. It shows that the strains which are genetically partial sterile to various degrees may arise from the roll-leaved plants which are always slightly sterile as compared with the normal-leaved plants.

The reverted normal-leaved plants arising from the roll-leaved ones amount to 1.32 per cent on the total of 907 individuals reared from the guarded seeds which are taken from the individuals in the segregating families in respect to the leaf character. The seeds taken from the isolated strains gave no reverters, the total number of the observed plants being 7680. The following table gives the summary of the result obtained in 1923. In it the data not discussed in the foregoing series are included which are based on the plants from the guarded seeds only.

TABLE 13

Parent	Normal-leaved fertile	Normal-leaved part. sterile	Total	Per cent P. S.
<i>NN</i>	5435	39	5472	0.69
<i>Nn'</i>	1575	19	1594	1.19
	Roll-leaved slightly sterile	Roll-leaved part. sterile	Total	Per cent P. S.
<i>n'n'*</i>	503	38	541	7.02
<i>n'n'**</i>	6721	959	7680	12.45
<i>n'n'§</i>	1	191	192	99.48
	Normal-leaved	Roll-leaved	Total	Per cent normal
<i>n'n'</i>	12	895	907	1.32
<i>n'n'</i>	0	7680	7680	0

* low partial sterile.

** high sterile plant.

§ isolated strain of high sterility.

The foregoing data show that there are certain normal-leaved fertiles which throw in every generation a few partially sterile plants. Otherwise they are constant fertiles and most likely homozygous for the factor

concerned. These partially sterile plants give rise by reversion to few fully fertile offspring, otherwise they are constant in respect to both partial sterility and normal leaf character. Even the roll-leaved plants produce in certain cases the normal-leaved fertile ones.

Summary

The partially sterile plants arising among the normal-leaved fertile plants in the progenies of the mutant family *NK* were studied by means of the pedigree cultures continued for five generations.

Certain normal-leaved plants throw in every generation a small number of partially sterile plants.

The partially sterile plants thus appearing breed true at once, but they also throw by reversion a small number of fertile plants.

The heterozygous normal-leaved plants (Nn') produce if not always nearly twice as many partially sterile plants as do the homozygous ones (NN).

The roll-leaved plants are partially sterile to very low grade, but they also produce more highly sterile individuals like those which arise from the normal-leaved plants.

The rate with which these partially sterile plants appear in the roll-leaved plants is greater than in the case of normal-leaved plants.

The writer wishes to thank Messrs. T. NIBE and G. INADUKA for their kind assistance.

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Zur Kenntnis fossiler Koniferenhölzer aus Japan

Von **Kametaro OHARA** (Nagoya)

Hierzu Tafel II

(Eingegangen am 19. Dezember 1925)

I. Braunkohlenhölzer der Provinzen Owari-Mino

a. BESTIMMUNGEN DER ARTEN

In den Provinzen Owari-Mino, Japan, vermutlich im jüngeren Tertiär,⁽¹⁾ kommen viele, ziemlich ausgedehnte Braunkohlenflöze vor. Die Arten der abgebauten Kohle⁽²⁾ sind verschieden. Man findet darunter hauptsächlich lignitische Braunkohlen mit zahlreichen Ligniten. Manchmal, besonders im Mino-Bezirk, kommt eine harte, muschelartig brechende Braunkohle (Fig. 3) vor, bei der die Inkohlung sehr fortgeschritten ist. Die Holzstruktur in dieser Braunkohle ist ganz verdrückt, so dass man nur von Harzparenchym herrührende, wellenförmige Linien und fast homogen erscheinende Tracheidenreste beobachten kann. Die Braunkohlen der vorliegenden Fundorte zeigen einen jungen Habitus; sie sind braun, fest, mit mattem Bruch, und spalten oft leicht nach der Schichtungsfläche.

Eine Art "Faserkohle," die später genauer erläutert werden soll, tritt auch häufig in den Flözen auf. Ausserdem kommt auf Bruchstückchen der Braunkohle "Holzkohle" (Russkohle) sehr oft vor. Letztere zeigt manchmal schuppenartige Form und unter dem Mikroskop parenchymatische Gewebestücke (Fig. 1-2). Die Natur der in "Holzkohle" umgewandelten Pflanzenteile kann nicht genau bestimmt werden. Sie scheinen jedoch nicht, wie die sonstigen fossilen "Holzkohlen" von Koniferenholz herzurühren; möglicherweise sind es Rindenteile. Aus den Braunkohlen dieses Fundortes habe ich einige Holzstücke (Lignite),

(1) Die Formation, in der die Flöze sich befinden, ist noch nicht genau bestimmt. Prof. KAWAMURA in Nagoya ist noch mit ihrer Erforschung beschäftigt.

(2) In der Nähe der Gruben gebraucht man die Braunkohle hauptsächlich als Hausbrand.

die guten Erhaltungszustand zeigen, zur Untersuchung ausgewählt.

Als Untersuchungsmethode habe ich die JEFFREYSche Methode,⁽¹⁾ d. i. die Vorbehandlung des Materials mit Flusssäure und Einbettung in Zelloidin, benutzt. Die Schnitte wurden in 5 μ Dicke mit dem Mikrotom hergestellt.

Cupressinoxylon sp. Ex. No. 6. Aus Nagakute, Prov. Owari.

Es handelt sich um einen etwa daumenstarken Aststumpf, der noch an einem Stammstück ansass. Er zeigt schwarzbraune Oberfläche und eine etwas hellere Farbe. Normal harzgangloses Coniferenholz. Jahresringe nicht scharf abgesetzt. Die Tracheiden mit spiraligen Streifungen; SANIOSche Balken deutlich, Tracheiden mit einreihigen runden Hoftüpfeln. Hoftüpfeln reichlich auch auf den tangentialen Wänden. Harzparenchymzellen zahlreich mit glatten Querwänden, über den ganzen Jahresring zerstreut. Markstrahlen einreihig, 1-6 Zellen hoch, nur aus Parenchymzellen mit glatten Wänden bestehend. Im "Kreuzungsfeld" ovale, "cupressoide" Markstrahl-Tüpfel, 1-3 im Spätholz, 1-6 im Frühholz. Pori im Frühholz mit Neigung zur "taxodioiden"⁽²⁾ Tüpfelung. Querschnitt der Markstrahlzellen rund bis oval.

Nach dieser Beschreibung erkennen wir in unserem Stück ein Holz von *Cupressinoxylon*- Bau,⁽³⁾ d. h. Abietineentüpfelung fehlt, Harzparenchym ist reichlich vorhanden. Unter den *Cupressinoxyla* unterschied GOTHAN⁽³⁾ auf Grund der Tüpfelung der Markstrahlzellwand 3 "Untergattungen"; *Glyptostroboxylon* CONW., *Taxodioxylen* und *Cupressinoxylon*. Von ihnen nimmt *Taxodioxylen* eine Mittelstellung zwischen den beiden anderen ein dadurch, dass die Poren der Markstrahl-Tüpfel im Frühholz sich bis zur "Eiporigkeit" erweitern.⁽⁴⁾

Unser Braunkohlenholz zeigt im ganzen zwar cupressoide Markstrahl-Tüpfel, lässt aber bereits eine gewisse Hinneigung zur "Eiporigkeit" wie bei *Taxodioxylen* erkennen (Fig. 4), d. h. Verschwinden der Behöfung. An den Markstrahlzellwänden habe ich auf den horizontalen und tangentialen Wänden keine Tüpfelung oder Verdickung gefunden; sie sind immer glatt und unverdickt (Fig. 4).

(1) JEFFREY, Anatomy of woody plants (1917), S. 447.

(2) GOTHAN, Zur Anatomie lebender und fossiler Gymnospermen-Hölzer 1905, S. 48-49.

(3) GOTHAN, l. c. S. 51.

(4) GOTHAN, l. c. S. 39-51.

Unser Befund an den fossilen Hölzern zeigt, dass zum Vergleich mit ihnen die folgenden lebenden Koniferen (Cupressineen) von denen ich Präparate eingesehen habe, nicht in Betracht kommen: *Thuja occidentalis*, *Chamaecyparis Lawsoniana*, *nutkaensis*, *pisifera*, *Cupressus Lindleyi*, *podocarpoides*, *pseudosabina*, *macrocarpa*.

Die Verdickung der Harzparenchymquerwände, die von GOTHAN⁽¹⁾ als ein charakteristisches Merkmal von *Taxodioxyton* erkannt worden war, fand ich nicht an meinem Holz, und daher ist eine Verwandtschaft mit *Taxodium* nicht anzunehmen. Durch dieses selbe Merkmal kann man es auch von *Cryptomeria japonica* DON. unterscheiden, die in fast allen Strukturen, in den Hoftüpfelverhältnissen, den glatten Markstrahlwänden, mit diesem Holz sehr nahe Verwandtschaft zeigt. YASUI⁽²⁾ beschrieb 1917 eine Art von Ligniten (Hölzern) aus denselben Flözen und gab Ihnen die Namen *Sequoia Hondoensis* als einer *S. sempervirens* nahestehenden Art. Den Nachweis hierfür hatte sie in der anatomischen Struktur des Holzes gefunden, wobei die folgenden Punkte als Bestimmungsmerkmale angegeben wurden, 1) Markstrahltüpfel, 2) Verbreitung des Harzparenchyms, 3) Vorkommen von "Bars of SANTO," 4) Traumatische Harzgänge.

Auf Grund dieser Bestimmungen meinte schon KRÄUSEL,⁽³⁾ dass "*Sequoia Hondoensis* mit *Taxodioxyton sequoianum* vereint werden könnte." Dieser Meinung möchte ich mich ebenfalls anschließen. Die Lignite, die ich als Untersuchungsmaterial benutzt habe, zeigten nicht die als Merkmal sicher wichtige Struktur der traumatischen Harzgänge, wobei aber zu berücksichtigen ist, dass ich mich besonders mit jüngeren Asthölzern beschäftigt habe. Ich habe zwar auch oft als Untersuchungsmaterial dicke Stämme benutzt, aber diese zeigten schlechte Erhaltung der Struktur des Holzes.

Es ist aber natürlich vom Zufall abhängig, ob man ein Holz mit Wundreizerscheinungen findet oder nicht; deswegen kann das Fehlen der traumatischen Harzgangserien nicht ohne weiteres als Diagnostikum benutzt werden. An einem andern verkieselten Holz von Manoura (Kiushiu) werden wir solche noch kennen lernen.

Der Form und Zahl der Markstrahltüpfel nach steht unser Holz

(1) GOTHAN, Die fossilen Koniferenhölzer von Senftenberg in Abb. Preuss. Geol. L. A. N. F., H. 46, S. 161, 1906.

(2) YASUI, K. A fossil wood of *Sequoia* from the Tertiary of Japan. Ann. of. Bot. 31 (1917).

(3) KRÄUSEL, Die Koniferenhölzer, Paläontograph., 62, 1919, S. 240.

mehr *S. sempervirens* als *gigantea* nahe.

Infolge der Mangelhaftigkeit der Beschreibung der Markstrahltüpfel bei *S. Hondoensis* konnte ich meine Lignite nicht weiter mit dieser vergleichen. Da man die Diagnostika, auf Grund deren man die Untergattung von *Cupressinoxylon* von einander unterscheiden kann, in guter Ausbildung nur in genügend altem Stamm- bzw. Wurzelholz, nicht in jungerem Astholz, wie ich es benutzen musste, beobachten kann, so können wir unser Holz nur unter die grosse Gattung *Cupressinoxylon* einreihen. Ob es unter den rezenten Coniferen zu *Sequoia* oder *Cryptomeria* Beziehungen hat, möchte ich hier also dahingestellt sein lassen. Als ein Merkmal von *Cryptomeria japonica* gibt man oft an, dass die Anzahl der Markstrahltüpfel auf einem Feld unter 3 bleibe. Dies gilt nicht immer, wie von IWAKI⁽¹⁾ in seiner japanischen Schrift nachgewiesen wurde. Es kommen manchmal bis 5 derselben im Kreuzungsfelde vor. Von diesem Standpunkt ist die Gattung *Cryptomeriopsis* von ORTMANN,⁽²⁾ die er auf Grund der Anzahl der Tüpfel als *Cryptomeria* nahe verwandte Gattung betrachtet hatte, fraglich.

Bei den Tracheiden bemerkenswert ist das deutliche Hervortreten von echten "SANIOSchen Balken" (Fig. 5) (nicht sogenannte "Bars of SANIO," wie von den JEFFREYSchen Schule oft die "SANIOSchen Streifen" bezeichnet werden: "rims of SANIO").

Taxodioxylon sequoianum MERKL. Ex. Nr. 5, Asahi-Gruben, Prov. Owari.

Ein Astholz vom 25 cm. Durchmesser, mit schwarzem kohligem Überzug, der von der Rinde herrührt. Innen ist das Holz hellbraun. Die Holzstruktur stimmt im Ganzen mit Ex. Nr. I. B. überein, jedoch zeigen, wie Fig. 7 erkennen lässt, die Markstrahltüpfel mehr die Beschaffenheit von *Taxodioxylon*, so dass ich die Zugehörigkeit zu *Taxodioxylon sequoianum* für sehr wahrscheinlich halte. Vergleiche über diese Art weiter hinten.

Die Tracheiden erscheinen im Querschnitt rund und lassen deutlich die Interzellularräume erkennen. Die Zellwände der Tracheiden zeigen deutlich mehrere Schichten und mit diesem Material habe ich die folgenden mikrochemischen Untersuchungen gemacht.

(1) IWAKI, I. Microscopical distinctions of some Japanese coniferous wood (auf Japanisch). Bot. Mag., Tôkyô S. 32, 1918, 380.

(2) ORTMANN, K. Beitr. Kenntnis tert. Braunkohlenh. Böhmens. Lotos, 70, 1922, S. 148 ff.

b. MIKROCHEMISCHES ÜBER EX. NR. 5

Gleich wie die rezenten Koniferenhölzer zeigt die Tracheidenwandung deutliche Schichtungen, besonders nach der Behandlung mit KOH-Lösung oder bei der Färbung mit Safranin. Die Mittellamella erscheint als helle lichtbrechende Linie deutlich ohne irgendwelche Behandlung. In der Zellwand kann man vier Schichten unterscheiden. Die Aeusserste fehlt manchmal und variiert in der Dicke, sofern vorhanden. Die zweite Schicht ist ziemlich dünn, die dritte ist recht mächtig, die vierte, innerste Schicht ist wieder dünn wie die zweite (Fig. 8).

Die folgenden Untersuchungen habe ich an Querschnitten gemacht, die mit dem Rasiermesser ohne Vorbehandlung angefertigt waren.

1. Zellulose-Reaktion

Auf das Vorkommen von Zellulose wurde Braunkohle nach R. POTONIÉ⁽¹⁾ schon im Jahre 1855 von FRANZ SCHULZE geprüft. Nach der Behandlung von Kohlen und Ligniten mit seinem dem Botaniker wohlbekannten Mazerationsgemisch ($\text{KClO}_3 + \text{HNO}_3$) und dann folgender Beseitigung von löslichen Stoffen durch Wasser und Ammoniak konnte er das Vorhandensein von Zellulose mit Chlorzinkjod erkennen. Seitdem gebraucht man gewöhnlich das SCHULZESCHE Gemisch für die Vorbehandlung der Kohle, um dann die Zellulose-Reaktion anwenden zu können. Wie schon R. POTONIÉ bemerkt hat, ist für die Untersuchung von Kohle auf Zellulose jedenfalls fast immer irgend welche Vorbehandlung nötig. Bei meiner Untersuchung blieb auch die Tracheidenwand bei Behandlung mit Chlorzinkjod und $\text{H}_2\text{SO}_4 + \text{J}$ immer gelb, anstatt sich violett zu färben. Unter den verschiedenen Reagentien, die^e von R. POTONIÉ als für die Vorbehandlung geeignet angegeben werden, habe ich folgende gewählt.

HOFMEISTERSCHES Reagens ($\text{K Cl O}_3 + \text{H Cl}$), Chlordioxydessigsäure "Diaphanol", KOH-Lösung und SCHULZESCHES Gemisch.

Mit SCHULZESCHEM Gemisch wurden die Schnitte zu leicht zerstört, so dass ich damit in meinem Falle niemals geeignetes Material für die mikroskopische Weiteruntersuchung bekommen konnte. Ausgezeichnete Erfolge ergab die Behandlung mit kochender KOH-Lösung. Da sich das Lignin bei rezenten Hölzern nicht mit KOH entfernen lässt, zeigt

(1) R. POTONIÉ: Der mikrochemische Nachweis fossiler kutinisierten und verholzter Zellwände sowie fossiler Zellulose und seine Bedeutung für die Geologie der Kohle. Jahrb. d. Preuss. Geol. Landesanstalt. **41**, I/1. 1920, S. 132.

sich also mit diesem entgegengesetzten Verhalten "fossilen Lignins", dass es sich in einem chemisch recht anderen Zustande befindet als das rezente.

Nach Waschen mit Wasser bekommt man dann die Zellulose-Reaktion mit Chlorzinkjod und $\text{H}_2\text{SO}_4 + \text{J}$ sofort, während bei Anwendung von Chlordioxydessigsäure und HOFMEISTERSchem Reagens die Schnitte erst nach einer 24-stündigen sorgfältigen Einwirkung der Reagentien zu weiteren Reaktionen brauchbar waren. Nach einer Vorbehandlung in der genannten Weise zeigte die Mittellamella mit Chlorzinkjod und $\text{H}_2\text{SO}_4 + \text{J}$ gelbe Farbreaktion. Die Zellwand selbst verhält sich gegenüber beiden Reagentien etwas verschieden. Mit Chlorzinkjodlösung wurde die erste Schicht violett, die zweite, dritte und vierte Schicht grauviolett gefärbt, unter ihnen die dritte dickste Schicht besonders deutlich. Mit $\text{H}_2\text{SO}_4 + \text{J}$ bekamen alle vier Schichten fast den gleichen blauen Farbton. Man kann durch diese Reaktionen leicht finden, dass die vier Schichten mehr oder minder Zellulose enthalten; besonders die dritte, dickste Schicht erscheint reich daran.

Nicht zu unterlassen war die Prüfung auf Zellulose mit der Kupferoxydammoniakreaktion. Ohne Vorbehandlung quillt die Tracheidenwand dabei nur ein wenig auf, die obigen Schichtungen deutlich zeigend. Bei der Vorbehandlung mit HOFMEISTERScher Lösung quillt sie dagegen sehr stark und löst sich leicht auf. Als ich die Reaktion durch Zugabe von Wasser verlangsamt hatte, konnte ich leicht die stärkst gequollene Schicht, die dritte, erkennen. Wie oben erwähnt, traten die Zellulosereaktionen der Schnitte bei Vorbehandlung mit KHO-Lösung mit Chlorzinkjod und $\text{J} + \text{H}_2\text{SO}_4$ sehr gut ein; in diesem Fall gelang aber die Lösung in Kupferoxydammoniak nur sehr schwierig.

Wie oben beschrieben verschwanden die Tracheidenwände in den Schnitten sehr leicht mit dem SCHULZESchen Gemisch, wogegen rezente Hölzer widerstandsfähiger sind. Im Vergleich zu rezenten Hölzern ging die Färbung der Tracheidenwände mit Safranin und Methylenblau (0,500 Lösung) sehr leicht vor sich und die Färbung war gegen Auswaschen haltbar. Aus den obigen Versuchen ergibt sich, dass in dem untersuchten Holzstück Oxyzellulose noch in grösserer Menge vorhanden ist.

2. Fett- und Harz-Reaktionen

In dem jetzigen Zustande der Mikrochemie hat man keine Reagentien, um Harz und Fett von einander scharf zu unterscheiden. Für

beide Substanzen ist Sudan III als geeignete Lösung bei den Botanikern angenommen. Mit diesem Reagens konnte ich die Schnitte des Lignits fast gleichmässig rot färben. Auf Grund dieser Reaktion hätte ich vielleicht den Schluss auf Vorhandensein von Fett gezogen, wenn ich nicht vorher eine Untersuchung mit Aether und Alkohol an einem über 24 Stunden extrahierten Schnitt gemacht hätte. Die Schnitte färbten sich nämlich auch dann deutlich rot. Bezüglich dieser Erscheinung hat R. POTONIÉ⁽¹⁾ schon in seinem Buch bemerkt, dass die vorschriftsmässig mit Benzol extrahierte bituminöse deutsche Braunkohle dieselbe Reaktion gibt. Jedoch bedürfe diese Erscheinung noch gründlicherer Untersuchung.

Daneben habe ich die mit Sudan III gefärbten Schnitte mit absolutem Alkohol gewaschen und nach gänzlichem Ausbleiben wieder mit demselben Farbstoff gefärbt, wobei die Schnitte sich wieder sehr deutlich rot färbten. Diese Behandlung konnte ich mehrmals mit denselben Schnitten wiederholen. Dadurch wird es sehr fraglich, ob diese Reaktion wirklich von dem Vorhandensein von Fettsubstanz in der Zellwand herrührt. Auch mit Rutheniumrot, dem für Pektinstoffe geeigneten Reagens, färbten sich die Schnitte gleichmässig sehr leicht ohne irgendwelche Vorbehandlung, wenngleich das Vorhandensein von Pektinstoffen in allen Teilen von Braunkohlen nicht anzunehmen ist. Meiner Meinung nach ist es höchst wahrscheinlich, dass diese beiden Erscheinungen von physikalischen Eigenschaften— nämlich starker Adsorptionsfähigkeit, die die Braunkohlen vielleicht durch den Kohlungsvorgang bekommen haben, nicht bloss von den chemischen Bestandteilen verursacht werden.

Mit conc. Schwefelsäure wurde die Mittellamella und die zweite und vierte Schicht der Zellwand dunkelbraun gefärbt, während die dritte, dickste Schicht rötlichbraun wurde. Die erste Schicht der Zellwand, die mit Chlorzinkjod violett gefärbt worden war, bleibt immer farblos.

Die Farbreaktion der genannten Schichten, die von RASPAIL als eine Reaktion der Eiweissstoffe betrachtet wurde, die durch den aromatischen Kern des Eiweisses bedingt ist, konnte ich auch an der rezenten *Cryptomeria japonica* (luftgetrocknetem Astholz) beobachten, obgleich die Farbe nicht so rötlich wurde wie bei den Fossilien. Ob diese Farbe, die von conc. Schwefelsäure hervorgerufen wird, von dem

(1) R. POTONIÉ: Einführung in die allgemeine Kohlenpetrographie, 1924, S. 242.

Vorhandensein eines aromatischen Kerns oder von dem Vorhandensein von Harzen herkommt, kann ich nicht entscheiden; man kann nur sagen, dass ein Stoff, der auf H_2SO_4 rot reagiert, in der Zellwand vorhanden ist.

3. Lignin-Reaktion

Ebenso wie R. POTONIE, konnte auch ich niemals mit Phloroglucin-Salzsäure Lignin-Reaktion in meiner Braunkohle beobachten. Aber bei Anwendung der MÄULESchen Reaktion konnte ich leicht bemerken, dass das ganze Gewebe gleichmässig schwarz-braun geworden war, nicht aber rot oder braunrot wie bei intaktem Lignin. Unter der MÄULESchen Reaktion versteht man ursprünglich die Behandlung (Oxydation) der Schnitte mit Kaliumpermanganatlösung und Zufügen von Ammoniak nach Waschen mit Wasser und Salzsäure. Da die Braunkohle einem Oxydationsprozess mit HOFMEISTERS Reagens ausgesetzt worden war, so war die Vorbehandlung mit Permanganatlösung unnötig. Bei meinen Exemplaren bekam ich sogar besseren Erfolg ohne Permanganat.

Im polarisierten Lichte blieb die Mittellamella immer dunkel, während die Zellwand grau leuchtete. Mit Gipsplättchen Rot. I. Ord. verhält sich die Zellwand positiv, d. h. man bemerkt grüne Additionsfarbe in der Richtung der Elastizitätsachsen des Gipses und gelbe Reduktionsfarbe im entgegengesetzten Sinne.

c. FASERLIGNIT

Ursprünglich wollte ich das vorliegende Material "Faserkohle" nennen. Wie bekannt, ist aber der Begriff "Faserkohle" sehr uneinheitlich, und man nennt recht verschiedene faserige Bildungen in der Kohle "Faserkohle." Es handelt sich hier um Aggregate von sehr fein zerfaserndem oder zerfasertem Holz, deren Aussehen Fig. 9 zeigt. Die Faserkohle besteht hauptsächlich aus sklerenchymatisch verdickten Tracheiden mit wenigem parenchymatischem Gewebe. Unter dem Mikroskope erweisen sich Präparate der zerfaserten Teile als tangentielle Schnitte von Koniferenholzstruktur, d. h. man erblickt die Markstrahlzellen (Fig. 9a) im Querschnitt, die Tracheiden im Längsschnitt. Wenngleich die Tracheiden mit einander noch fest verkittet erscheinen, sind die Mittellamellae schon verschwunden, so dass ich nicht leicht Querschnitte herstellen konnte. Derartige "Faserkohle" entsteht, wie ich mich auch an ähnlichem Material in der Preuss. Geolog. Landesanstalt überzeugte, dadurch dass die Zerfaserung von Braunkohlenligniten

nach zwei auf einander senkrechten Hauptrichtungen erfolgt; 1) nach den Tracheen der Jahresringe (indem sich die dicke Spätholzschicht des jüngeren von der Frühholzschicht des späteren Ringes ablöst); 2) nach der Radialrichtung.

In dem vorliegenden Spezialfall kommt hinzu der weitere Zerfall infolge Verschwindens der Mittellamellen. Das Auffällige bei der vorliegenden (und ähnlichen) Faserkohle ist die Biegsamkeit der Tracheiden, die sonst bei den Ligniten spröde und zerbrechlich sind. Die Tracheiden sind stark verdickt, so dass die Holztüpfel in Form kleiner von der "Mittellamelle" ausgehender Kanäle erscheinen (Fig. 9a).

An der Faserkohle konnte ich mikrochemisch die MÄULESCHE Reaktion mit Erfolg anwenden. Nach der Behandlung mit den drei oben erwähnten Lösungen zeigten die Tracheidenwände deutliche Zellulosereaktion, d. i. durch Chlorzinkjod Violett-, (besonders in der innersten Schicht), durch $H_2SO_4 + J$ Blau-Färbung. In Kupferoxydammoniak lösten sich die Tracheidenwände leichter als die der anderen Lignite. Vielleicht liegt die hohe Biegsamkeit der Fasern an dem relativ hohen Zellulosegehalt.

Mit Sudan III färbten sich die Gewebe gleichmässig rot, so dass hier ein ähnliches Verhältnis wie bei dem vorigen Lignit vorliegt.

Die eben besprochene Faserkohle ist also eine merkwürdige Art der Erhaltung von Lignitstücken, bei denen neben der überaus feinen Zerkleinerung die geringe Brüchigkeit des Materials auffällt, so dass diese Art Kohle wohl zu den merkwürdigsten Erscheinungen in der Braunkohle gehört. Aus den in der Preuss. Geol. Landesanstalt mir von Herrn Prof. GOTHAN gezeigten Stücken ergibt sich, dass ganz ähnliche Vorkommen, die wir nach den obigen Erläuterungen nunmehr passend als "Faserlignite" bezeichnen wollen, in jüngeren deutschen Braunkohlen ebenfalls vorkommen, z. B. in der Nieder-Lausitz, in der rheinischen Braunkohle. Bei vollständiger Zerkleinerung sieht man den Faserligniten ihre Herkunft zunächst an, sondern das Mikroskop lehrt erst den Sachverhalt kennen (vgl. auch R. POTONIÉ, 1925).

II. Verkieselter Lignit (Matsuiwa) aus Kiushiu

"Matsuiwa" (Kiefernstein)⁽¹⁾ ist der bei den Bergleuten an der

(1) Nach brieflicher Mitteilung von Prof. TANIYAMA kommen die "Kiefernsteine" besonders im Südbezirk des Chikuho Flözes und zwar in seinen untersten Schichten vor. Es handelt sich dabei nach den neuesten Forschungsergebnissen wahrscheinlich um Pliozän, nicht, wie man früher annahm, um Miozän.

Fundstelle gebräuchliche Ausdruck für die fossilen Hölzer, die häufig in tertiären Steinkohlenflözen von Kiushiu, Japan vorkommen. Manchmal treten sie in der Form dicker Stümpfe, daher der Name "Matsuiwa."

Die Materialien der untersuchten verkieselten Hölzer sind mir von Herrn Prof. TANIYAMA an der Technischen Meiji Hochschule zur Untersuchung überlassen worden, wofür ich ihm zu herzlichem Dank verpflichtet bin. Die Exemplare, die mir zur Verfügung standen, sind alle stark verkieselt, derart, dass sie erst durch Dünnschliffe⁽¹⁾ für die mikroskopische Untersuchung geeignet wurden.

Man trifft diese Baumstämme teils aufrecht stehend, teils liegend an. Im letzteren Falle sind sie in der Regel gequetscht und werden dann als Gürtelsteine ("Obiwa") bezeichnet.

Insgesamt bilden die Kiefernsteine einen erheblichen Teil des ganzen Flözes, wenigstens 10%, stellenweise bis 60%. Soviel ich in Erfahrung bringen konnte, ist das Vorkommen von verkieselten Ligniten in steinkohliger Kohle noch nicht beobachtet worden. Es hat jedoch seine Parallele z. B. in dem Vorkommen von Kieselhölzern in der sächsischen Braunkohle (Gr. Clara bei Gröbers bei Leipzig), von wo mir Prof. GOTHAN Exemplare zeigte, die auch aus der Kohle selbst stammen. Wäre diese Braunkohle durch Gebirgsfaltung etc. in steinkohlische Beschaffenheit übergegangen, so hätten wir ein vollständiges Analogon zu dem japanischen Vorkommen.

Taxodioxydon sequoianum (MERCKL.) SCHMALH. erw. GOTHAN em. Ex.

III. Ein stark gepresstes, schwarzes Astholz aus Manoura bei Naokata.

Normal harzgangloses Coniferenholz. Traumatische Harzgänge in tangentialer Reihe im Spät- und Frühholz scharf abgesetzt. Die Tracheiden mit einreihigen runden getrennten Hoftüpfeln; SANIOSche Streifen undeutlich; Hoftüpfel auf den tangentialen Wänden reichlich. Harzparenchymzellen kurz und rechteckig mit glatten Wänden, zerstreut über den ganzen Jahresring. Markstrahlen einreihig, 1-12 Zellen hoch, aus Parenchymzellen mit glatten Wänden bestehend. Im Kreuzungsfelde 1-4 Tüpfel im Frühholz mit cupressoid-taxodioiden Poris.

Ex. I. Ein graues Bruchstück von einem vermutlich dickeren Stamme aus Manoura. Die Holzstruktur ist sogar mit der Lupe erkennbar. Stimmt mit dem vorigen in fast allen Punkten überein. Trauma-

(1) Die Dünnschliffe für meine Untersuchung wurden nach meiner Bestellung von VOIGT und HOCHGESANG, Göttingen gefertigt.

tische Harzgänge fehlen hier. Hoftüpfel 1-2-reihig, opponiert, mit deutlichen SANIOSchen Streifen. Die Parenchymzellen sind kurzzeitig und enthalten zusammengeballte Harzkügelchen. Markstrahlen manchmal 2-reihig, 1-20 Zellen hoch. Markstrahltüpfel im Kreuzungsfelde 2-4, im Frühholz 1-2 im Spätholz.

Die obigen 2 Hölzer kann man meiner Meinung nach in derselben Art vereinigen, obgleich sie in der Struktur etwas abweichend sind. Diese Abweichungen kommen aber vom verschiedenen Alter der Hölzer her, das erstere zeigt die Struktur eines jüngeren Holzes, während das letztere älter ist. In den diagnostisch wichtigen Punkten: in Form und Anzahl der Markstrahltüpfel, im Harzparenchym, im Querschnitt der Markstrahlzellen stimmen beide Hölzer überein, mit Ausnahme der traumatischen Harzgänge, deren sporadisches Auftreten nur als Folge von Wundreiz zu erklären ist (Fig. 12). Durch diese traumatischen Harzgänge lässt sich die Gattung *Sequoia* unter den *Taxodioxylo* nach der Holzstruktur bestimmen, dank der JEFFREYSchen Arbeit,⁽¹⁾ wovon oben die Rede war. Durch die weitere von ihm angegebene Tatsache, dass die vertikalen Harzgänge bei *Sequoia sempervirens* ENDL. im Spätholz, bei *S. gigantea* TORR. im Frühholz auf Wundreiz angelegt werden, sollen sich die beiden Hölzer von einander unterscheiden lassen. Da die Harzgänge in unserem Holz im Spätholz auftreten, würde man an nahe Verwandtschaft mit *Sequoia sempervirens* denken, zumal alle übrigen Strukturverhältnisse auf sie passen.⁽²⁾ Besonders die Markstrahltüpfel stimmen in Form und Anzahl mit der rezenten *S. sempervirens* bzw. *Taxodioxylon sequoianum* überein.

Von *Taxodium distichum* kann man unsere Stücke durch den Mangel der Verdickung auf den Querwänden des Harzparenchyms unterscheiden. GOTHAN⁽³⁾ hat in seiner Arbeit zur Erkennung von *Taxodium* und Verwandten ein wesentliches Merkmal dargelegt, das in den Markstrahltüpfeln liegt, "die stets \pm gedrängt, in Mehrzahl auf dem Felde stehen, und der Form nach einen Übergang zwischen dem rein cupresoiden und glyptostroboiden Markstrahltüpfeltypus bilden." Er hat

(1) JEFFREY, C. Ed. The Comparative anatomy and phylogeny of the Coniferales. Pt. 1. The Genus *Sequoia* (Memoirs Boston Soc. Nat. Hist. 5, 110, 10, 1903).

(2) Ob die Diagnostizierung auf Grund der Harzgangbildung im Früh- resp. Spätholz als Unterscheidungsmerkmale der beiden Sequoien gelten können, scheint mir noch nicht ausgemacht.

3) GOTHAN, W. l. c. (1905).

diesem Typus der Sammelgattung *Cupressinoxylon* den Gattungsnamen "*Taxodioxyton*" gegeben, in dem die mit dem rezenten *Taxodium* und *Sequoia sempervirens* übereinstimmenden Hölzer einbegriffen sind. Weiter hat er für das Taxodienholz, das mit *S. sempervirens* übereinstimmt, den Artnamen *Taxodioxyton sequoianum* (MERCKL. SCHMALH. erw.) GOTH. em., der 1855 von MERCKLIN gegeben und 1883 von SCHMALHAUSEN emendiert worden war, im Anschluss an die Abbildungen SCHMALHAUSENS empfohlen. Unseren Hölzern möchte ich auch diesen Namen geben, der *S. sempervirens* entsprechende Fossilienformen bezeichnet.

Im Anschluss an den Nachweis von *Taxodioxyton sequoianum* in japanischen Tertiär sei bemerkt, dass von NATHORST⁽¹⁾ schon im Jahre 1883 bzw. 1888, n. 5) *Sequoia disticha* HEER, und n. 7) *S. Tournalii* BRONG. in Form von Blattresten angegeben worden sind (allerdings von anderen Fundorten), die ebenfalls in den Formenkreis von *Sequoia sempervirens* hineingehören, so dass diese Formengruppe jetzt durch Blatt- und Holzreste dort nachgewiesen ist. NATHORST gibt ausserdem aber noch *Taxodium distichum* an (l. c. p. 7), und diese Conifere wird auch neuerdings noch wieder von FLORIN,⁽²⁾ aber mit? angeführt, diese Art ist also durch Holz in Japan noch nachzuweisen.

Die vorliegende Untersuchung wurde im Palaeobotanischen Institut der Geologischen Landesanstalt, Berlin angefertigt, wo ich mich der Unterstützung von Prof. GOTHAN erfreute, das mir auch seine Literatur, Präparate etc. in dankenswerter Weise zur Verfügung stellte.

(1) NATHORST, A. G. Zur fossilen Flora Japans, Paläont. Abb. IV. 3, 1888.

(2) FLORIN, Zur Kenntnis der jungtertiären Pflanzenwelt Japans. Kgl. Soc. Vet. Ab. Handl. 61, 1, 1920.

Figurerläuterungen der Tafel II

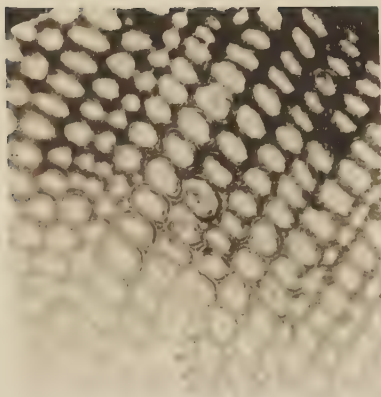
- Fig. 1-2. Gewebestückchen aus der "Holzkohle" ("Russkohle") von Owari-Mino. Parenchymatische Gewebereste. L. IV \times 7.
- Fig. 3. Sehr homogenes Holz, Querschnitt, die erwähnte schwarze, muschelrig brechende Lignitkohle bildend. L. 0 \times 5.
- Fig. 4-3. *Cupressinoxylon* sp. Nagakute, Owari. Radialschnitt mit Markstrahlhäpfeln und Harzparenchym. L. IV \times Z. D.
- Fig. 5. Radialschnitt mit Hoftäpfeln und "SANTOSchen Balken" (Bars of SANTO). L. IV \times Z. D.
- Fig. 6. Tangentialschnitt mit Tangentialhottäpfeln und Harzparenchym. L. IV \times Z. D.
- Fig. 7. *Taxodioxylon sequoianum*. Asahi, Owari. Stück eines Radialschnitts mit taxodoiden-Markstrahlhäpfeln. L. IV \times Z. D.
- Fig. 8. Querschnitt durch ein Astholz (*Taxodioxylon sequoianum*), an dem die beschriebenen mikroskopischen Reaktionen vorgenommen wurden. Die 4 Schichten der Zellenwand sind in der Mitte des Bildes deutlich wahrnehmbar. L. 4 \times 7
- Fig. 9. Ansicht des Faserlignits von Owari-Mino, ungefähr in 1/1; der zerfaserte Teil zeigt noch deutliche Holznatur.
- Fig. 9a. "Faserlignit"-Stückchen; die Struktur der Tangentialschnittes des Koniferenholzes ist deutlich sichtbar. Bei $\times \times 2$ Markstrahlen. L. IV \times Z. D.
- Fig. 10. *Taxodioxylon sequoianum* von Manoura (Kiushiu) ("Matsuiwa," Kiefernstein). Radialschliff mit Markstrahlhäpfeln L. IV \times Z. D.
- Fig. 11. Tangentialschliff mit Markstrahlen und Harzparenchym. L. IV \times Z. D.
- Fig. 12. Querschliff mit Jahresringen und einer Serie von traumatischen Harzgängen. L. IV \times Z. D.



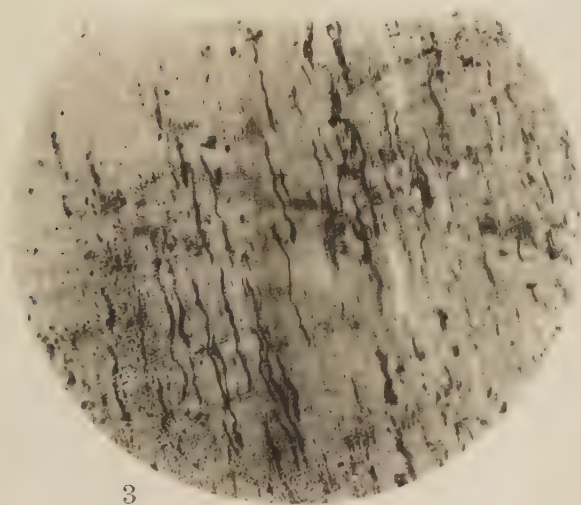
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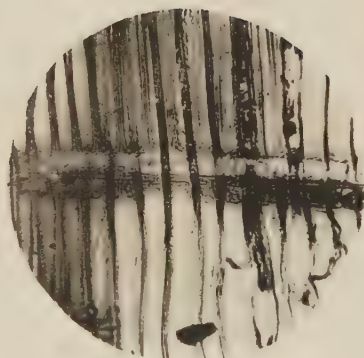
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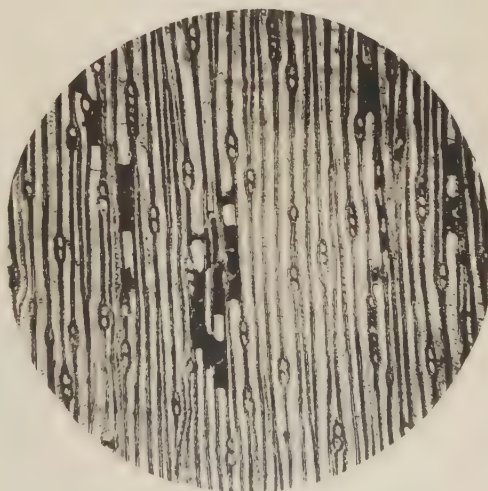
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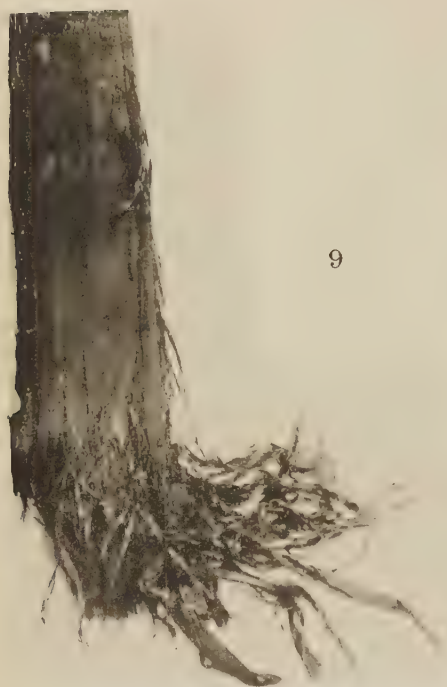
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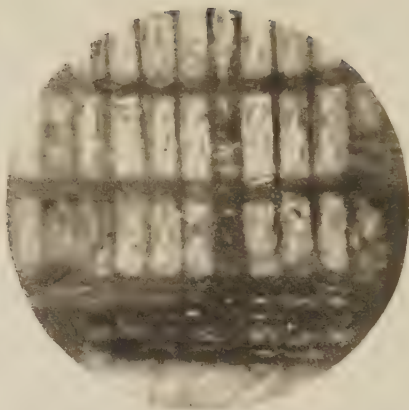
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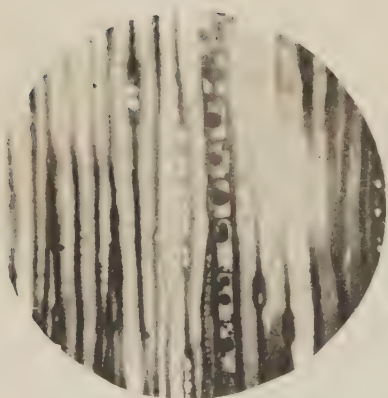
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Über die experimentell veranlasste Entstehung von keimfähigen Pollenkörnern mit abweichenden Chromosomenzahlen

Von Tetsu SAKAMURA und Isamu STOW

Mit Tafel III und 22 Textfiguren

(Aus dem Botanischen Institut der Hokkaido Kaiserl. Universität, Sapporo.
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Einleitung

Beispiele der polyploiden und anderen Beziehungen der Chromosomenzahl unter naheverwandten Arten, Varietäten oder manchmal Kulturrassen der Pflanzen sind in den letzten Jahren immer mehr bekannt geworden, und die stetige Untersuchungen verschiedener Forscher auf diesem Gebiete haben natürlich wesentliche Fortschritte in der genetischen Karyologie gebracht.

Es muss sehr interessant und lehrreich sein, wenn man Pflanzen mit abweichenden Chromosomenzahlen experimentell erzeugen kann. Es ist in der Tat EL. und EM. MARCHAL (1911) und WETTSTEIN (1924) an einigen Laubmoosen durch experimentelle Aposporie und WINKLER (1916) durch Adventivsprossbildung bei *Solanum* geglückt, polyploide Pflanzen zu erhalten, bei vielen davon tritt der Riesenwuchs äusserlich in Erscheinung.

Dass andererseits das Vorkommen der Riesenpollenkörner und das Auftreten von triploiden und tetraploiden Mutanten schon früher bei *Oenothera* und nachher bei anderen Pflanzen bestätigt wurde, hat uns auf die Möglichkeit hingewiesen, dass die Polyploidie hauptsächlich infolge der Befruchtung der Gameten mit diploider oder triploider Chromosomenzahl entstehen kann.

NĚMEC (1910) und SAKAMURA (1920) narkotisierten die Antheren und erzeugten dadurch junge Pollenkörner mit abweichenden Chromosomenzahlen. Es geht auch aus den Untersuchungen von SAKAMURA (1920), BORGSTAM (1922) und von BELLING (1925) hervor, dass niedrigere Temperatur ebenso stark auf die Reduktionsteilung der Pollenmutterzellen

einwirkt wie Narkotika, wodurch Riesen- oder Zwergpollenkörner erzeugt werden. Aber die genannten Forscher haben damals weder Keimfähigkeit noch Fertilität dieser Pollen festgestellt.

Seit einigen Jahren erschienen die interessanten Arbeiten von DE MOL,⁽¹⁾ worin er mitteilte, dass aus den Antheren der im Gewächshause kultivierten Hyacinthen diploide (of duplicate generative nuclei) Riesenpollenkörner erzeugt wurden, und dass er durch Bestäubung mit solchen abnormen Pollenkörnern drei triploide Keimlinge bekommen konnte. Die Entstehung von solchen Pollen hat er auf physiologische Reize (physiological stimuli) zurückgeführt, deren Bedeutung uns aber etwas unklar bleibt.

In dieser Richtung muss noch jene erfolgreiche Arbeit von WETTSTEIN (1924) genannt werden, wonach er sowohl durch die Regeneration als auch durch die mittels der Chloralisierung hervorgerufene gestörte Reduktionsteilung polyploide Pflanzen entstehen liess. Aber eine eingehende cytologische Untersuchung der Reduktionsteilung wurde dabei nicht ausgeführt.

Unterdessen hat der eine von uns (Stow) in einer anderen cytologischen Arbeit über die Sterilität der Pollenkörner von *Solanum tuberosum*⁽²⁾ bestätigt, dass die Reduktionsteilung der Pollenmutterzellen dieser Pflanze stark durch die Temperatur beeinflusst wird, nämlich dass sie bei höherer Temperatur (25°–30°C) abnorm, bei niedrigerer Temperatur (15°–25°C) normal vor sich geht. Im ersteren Falle werden sterile Pollenkörner von verschiedenen Größen und im letzteren Falle fertile, gleichgrosse Pollenkörner erzeugt. Obschon SAKAMURA, BORGSTAM und BELLING sich mit dem Versuche über die Einwirkung der niederen Temperatur auf die Teilungsvorgänge der Pollenmutterzellen beschäftigt haben, so kennen wir bisher keine solchen Untersuchungen über den Einfluss höherer Temperatur.⁽³⁾

Aus den oben erwähnten Studien von Stow kann man erkennen, dass die Temperatur an heissen Sommertagen, die aber für unsere Vegetation nie zu hoch scheint, auf die Reduktionsteilung der Pollenmutterzellen wenigstens einiger Pflanzen, z. B. Kartoffel, etwas unnatürlich einwirkt. In dieser Beziehung muss besondere Aufmerksamkeit auf die Saisonperiodizität der Pflanzen gerichtet werden. Das Ruhe-

(1) Nur eine dieser Arbeiten ist uns hier zugänglich.

(2) Diese Arbeit wird a. a. O. veröffentlicht werden.

(3) Die Einwirkung hoher und tiefer Temperatur (35°–2°) wurde von WETTSTEIN mit negativem Erfolg versucht.

bezw. Entwicklungsstadium ist, wie schon bekannt, je nach den Pflanzenarten oder je nach den Organen in ein und derselben Pflanze verschieden. Die meisten Pflanzen entwickeln im Frühling oder Sommer die Blumen und Blätter und führen üppiges Wachstum aus (Gruppe I), während das bei den anderen viel eher im Herbst oder Winter geschieht, wo der menschlichen Beurteilung nach die niedere Temperatur der Pflanzenentwicklung Nachteil zu bringen scheint (Gruppe II). Zur letztgenannten Pflanzengruppe gehören *Hyacinthus*, *Gagea*, *Narcissus*, *Adonis* u. a., die man oft als Zierpflanzen im Gewächshause kultiviert. Es ist nicht schwierig zu begreifen, dass für die Organentwicklung solcher Pflanzen die künstlich sommerlich erhöhte Temperatur zu abnorm hoch ist. Wenn diese Gruppe Pflanzen (II) im Herbst oder Winter in ein warmes Gewächshaus oder warmen Beetkasten versetzt werden, gerade während die Reduktionsteilung der Pollenmutterzellen vor sich geht, wäre nicht unmöglich, dass diese in unregelmässige Zustände fällt, wie man aus der cytologischen Tatsache bei der Kartoffel vermuten kann. In diesem Falle werden natürlich entweder sterile oder fertile aber abnorm chromosomige Pollenkörner erzeugt, je nach dem Grade der Einwirkung der Temperatur. Diese Vermutung scheint umso wahrscheinlicher, als im Gewächshause bei mehreren Pflanzen die Blumen trotz der künstlichen Bestäubung steril bleiben und daneben, wenn fertil, manchmal die die Polyploidie begleitende Variation stattfindet.

Obwohl es nach den oben genannten Arbeiten einigen Forschern gelang, sich experimentell polyploide Pflanzern zu verschaffen, so ist das diesbezügliche Problem bei Phanerogamen noch nicht aufgeklärt. Deshalb scheint es uns wünschenswert und sogar notwendig zu sein, im ersten Teil unserer Untersuchung Versuche über die experimentelle Erzeugung der keimfähigen Pollenkörner mit abweichenden Chromosomenzahlen anzustellen, wobei die allgemein in der Natur oder unter Kulturbedingungen für gewöhnlich auftretenden und mässig wirksamen Faktoren als Reize in Betracht gezogen werden.

Im Dezember des Jahres 1925 glückte es uns, Blumenknospen von *Gagea lutea*, die sich noch unter der Erde befanden, als der Schnee die Erde noch nicht bedeckte, zu untersuchen. Wir haben mittels der Essigkarmin-Methode bestätigt gefunden, dass in diesen Blumenknospen, die unterirdisch bei so niedriger Erdtemperatur wie 1°–2°C sich entwickeln können, die Pollenmutterzellen schon in der meiotischen Teilung begriffen waren. Diese Tatsache und dazu noch der Umstand, dass *Gagea lutea* bisher nie kultiviert worden und die individuelle Variation der Chromoso-

menzahl kaum denkbar ist, veranlassten uns, mit dieser Pflanze unsere experimentelle Versuche ohne weiteres anzufangen, um die Möglichkeit der Entstehung der Polyploidie durch gestörte Reduktionsteilung bei Phanerogamen noch zu ergänzen.

In den Versuchen gelang uns, wie erwartet, die abnormen, aber keimfähigen Pollenkörner mit abweichenden Chromosomenzahlen zu erzeugen. Durch die Bestäubung solcher Pollen, die allerdings etwas mit den normalen gemischt sind, haben wir schon eine reichliche Menge Samen bekommen; ein Teil davon wurde gesät, um mit grossem Interesse die Keimlinge karyologisch weiter zu untersuchen.

In der vorliegenden Arbeit möchten wir die bisher erreichten Resultate zusammenfassend mitteilen; die ausführlicheren zukünftigen Untersuchungen an *Gagea lutea* und noch anderen Pflanzen werden hauptsächlich durch den einen von uns (Stow) fortgesetzt werden.

Material

Die Versuchspflanzen *Gagea lutea*, die im Botanischen Garten hiesiger Universität wild gewachsen waren, wurden vom 3ten bis zum 8ten Dezember 1925 herausgegraben, in Töpfe gepflanzt und mit Tuch bedeckt im Korridor des Laboratoriums (-2.5° – $+10^{\circ}\text{C}$) aufbewahrt. Nach Bedarf wurden Pflanzen herausgenommen.

Zur mikroskopischen Beobachtung der Kernteilung wurde die zweite Methode von BELLING (1921) mit Essigkarminlösung angewendet, deren Gebrauch für die Untersuchung der reifen Chromosomen sehr bequem und erfolgreich, während sie für diejenige der prophasischen sowie telophasischen Chromosomen und für die Färbung des ruhenden Kernes nicht ebenso befriedigend ist.

Normale Kern- und Zellteilung der Pollenmutterzellen von *Gagea lutea*

Zunächst haben wir im Material, das aus den im Botanischen Garten ausgegrabenen Pflanzen entnommen wurde, bestätigt gefunden, dass die hetero- und homöotypische Kern- und Zellteilung ganz normal vor sich geht.⁽¹⁾ Da die Studien über die Teilungsstunden vor der Metaphase der ersten Teilung mit dem vorliegenden Problem nicht in direkter Beziehung stehen, so möchten wir mit der Metaphase unsere Beschreibung anfangen.

(1) Die Erdtemperatur betrug damals 1° – 2°C .

In der Metaphase der heterotypischen Teilung ordnen sich die Chromosomen ganz regelmässig auf der Kernplatte, und in der Polansicht kann man ohne Schwierigkeiten die Geminizahl 36 bestimmen (Fig. 1). Die haploide Chromosomenzahl dieser Pflanze beträgt also 36, die höchste Anzahl, die in Liliaceen bisher gefunden worden ist.⁽¹⁾ Die Verteilung homologer Chromosomen an beiden Polen ist regelmässig. Die Scheidewandbildung am Ende der ersten Teilung beginnt mit dem Auftreten der Phragmoplasten und geht zentrifugal vor sich.

In der homöotypischen Teilung kann man die reduzierte Chromosomenzahl 36 bestätigen. Die Einschnürung, die die Chromosomen an bestimmten Stellen besitzen, ist bemerkbar (Fig. 2). Nach der normalen Kern- und Zellteilung werden die Tetradenzellen gebildet, von denen jede gleichmässig 36 Chromosomen enthalten soll. Die Scheidewand wird infolge der Zellplattbildung zentrifugal gebildet, wie in der ersten Teilung.

Abnorme Reduktionsteilung der Pollenmutterzellen, die durch höhere Temperatur hervorgerufen wurde

Je fünfzehn Pflanzen wurden in ein Glasgefäss so eingesetzt, so dass die Zwiebel mit Erde bedeckt war, während die aus der Zwiebel herausgesprossenen Blätter, unter denen die Blumenknospen noch versteckt sind, in der Luft frei gelassen wurden. Dann wurden die Pflanzen in einen Thermostat von bestimmter Temperatur gelegt. Nach Verlauf einer bestimmten Versuchsdauer wurden die Pflanzen mit dem Glasgefäss zusammen herausgenommen und wieder im Korridor in schon erwähnter Weise zu nachherigem Gebrauch aufbewahrt. Die Kontrollpflanzen, die durch die höhere Temperatur nicht beeinflusst wurden, blieben stets an demselben Ort. Nach dem letzten 3-6 tätigen Verweilen im Korridor wurden alle Kontroll- und Versuchspflanzen ins Gewächshaus (13°-31°C) überbracht, um die weitere Entwicklung der Pollen und das Blühen zu beschleunigen.

VERSUCH I

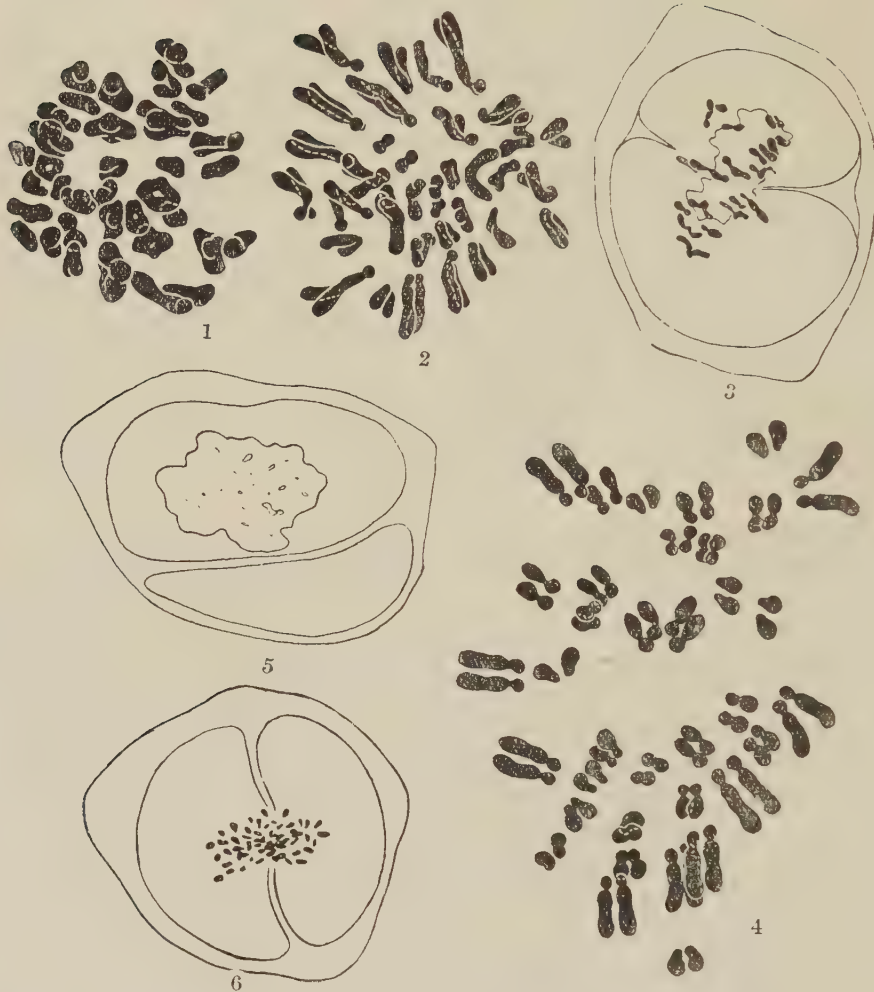
15-16/XII 1925.

Temperatur 25°C, Wirkungdauer 15 Stunden.

Sofortige Beobachtung:

Keine besonderen Anomalien der Chromosomenverteilung werden an den beiden Polen der ersten oder zweiten Teilung beobachtet. Die

(1) TISCHLER, Pflanzenkaryologie. S. 581-586.



- Fig. 1. Polansicht der heterotypischen Kernplatte. 36 Gemini. Vergr. 1310.
- Fig. 2. Polansicht der homöotypischen Kernplatte. 36 Chromosomen. Einschnürung; der Chromosomen ist sichtbar. Vergr. 1880.
- Fig. 3. Versuch I. Sofortige Beobachtung. Metaphase der heterotypischen Kernteilung. Die Scheidewand ist zur Kernplatte schräg gebildet. Vergr. 825.
- Fig. 4. Versuch II. Sofortige Beobachtung. Metaphase der homöotypischen Kernteilung. Einschnürung der Chromosomen ist sehr deutlich sichtbar. Vergr. 2080.
- Fig. 5. Versuch III. Beobachtung nach 24 Stunden. Infolge der abnormen heterotypischen Teilung zwei Zellen gebildet. Der eine enthält die ganzen Chromosomen, die andere ist kernlos. Vergr. 825.
- Fig. 6. Versuch III. Beobachtung nach 98 Stunden. Metaphase der heterotypischen Teilung. Die Scheidewand ist zur Kernplatte vertikal gebildet. Vergr. 825.

Scheidewandbildung geschieht etwas verschieden von derjenigen der normalen Teilung. Von Karyokinese und Verbindungsfasern ganz unabhängig wird der Cytoplasmakörper eingeschnürt und dies schreitet zentripetal immer nach Innen fort. Während die Chromosomen noch auf der Kernplatte sich befinden, ist die Einschnürung bisweilen schon so stark geworden, dass nur der zentrale Plasmateil intakt bleibt (Fig. 3). Nur selten ist zentripetales Innenwachstum des inneren Teiles der Membran der Mutterzelle ersichtlich.

VERSUCH II

5/XII 1925.

Temperatur 30°C, Wirkungsdauer 8 Stunden.

Sofortige Beobachtung:

Die Gemini sind verkürzt. Einige Chromosomen sind dann und wann aus der Kernplatte ausgeschlossen und isoliert im Cytoplasma zerstreut. In der Metaphase der zweiten Teilung treten die Einschnürung der Chromosomen noch deutlicher auf, die auf der Kernplatte mit grossen Zwischenräumen zerstreut sind (Fig. 4). Die Wanderung der Chromosomen nach den Polen wird oft gestört, infolgedessen werden einige Chromosomen im Cytoplasma isoliert zurückgelassen. Die Scheidewand wird meisten durch Einschnürung des Cytoplasmakörpers gebildet, die bisweilen das zentripetale Membranwachstum der Mutterzelle begleitet.

VERSUCH III

8-9/XII 1925.

Temperatur 30°C, Wirkungsdauer 15 Stunden.

Sofortige Beobachtung:

Sowohl in der ersten wie in der zweiten Teilung wird die Wanderung der Chromosomen gestört und daraus folgt dieselbe Erscheinung des Zurückbleibens einiger Chromosomen wie sie im vorhergehenden Versuche erwähnt worden ist. Nicht selten gruppieren sich alle Chromosomen einzentrisch und ein grosser Kern rekonstruiert sich daraus (Fig. 5). Die Scheidewandbildung infolge der Einschnürung ist ganz unabhängig von Karyokinese; sie wird gestört und geht der Kernrekonstruktion voraus. Später, nach 98 Stunden, bemerken wir, dass die Chromosomen immer noch in demselben Zustand geblieben sind, während die Scheidewandbildung schon früher fast vollendet war (Fig. 6).

Die Beobachtung nach 24 stündigem Verweilen im Korridor:

Infolge der oben erwähnten unregelmässigen Verteilung der Chromosomen auf die Tochterzellen sowie der abnormen Scheidewandbildung



Fig. 7. Versuch III. Beobachtung nach 24 Stunden. Tetradenzellen, die die unregelmässig zerstreuten Chromosomen enthalten. 35, 38, 37 bzw. 33 Chromosomen in der einzelnen Zelle. Vergr. 940.

Fig. 8. Versuch III. Beobachtung nach 24 Stunden. Tetradenzellen. Chromosomen ordnen sich auf einer Platte. Chromosomenzahl beträgt nicht gleich in jeder Zelle; 34 und 37 Chromosomen. Eine Zelle enthält einen ruhenden Kern. Vergr. 940.

Fig. 9. Versuch III. Beobachtung nach 24 Stunden. Eine Chromosomengruppe aus einer Tetradenzelle. Längsspaltung ist bemerkbar. Vergr. 940.

werden zwei oder noch mehr Tochterzellen erzeugt, worin je ein grosser Kern oder mehrere kleine Kerne enthalten sind. Der Kern ist dabei noch nicht in vollständigen Ruhezustand eingetreten, und die Kernrekonstruktion geschieht im allgemeinen verzögert. Es ist natürlich nicht leicht zu entscheiden, ob diese Tochterzellen aus der abnormen ersten oder zweiten Teilung gekommen sind. Wir finden oft Tetradenzellen, von denen jede Zelle noch verkürzte Chromosomen unregelmässig zerstreut enthält (Fig. 7).

Die Beobachtung nach längerem Verweilen im Korridor:

Nach 33 oder 55 Stunden nimmt man in ein und derselben Mutterzelle die die unregelmässig angeordneten Chromosomen enthaltenden Tochterzellen wahr, gemischt mit denjenigen, welche ruhende Kerne aufweisen. Die Figur der erstgenannten Tochterzellen ähnelt nur scheinbar der metaphasischen Kernplatte, und einige Chromosomen weisen die Längsspalte auf (Fig. 8, 9; Taf III, Mikrophoto. 1).

Nach 79 Stunden nimmt die Zahl der jungen Pollen mit ruhendem Kern zu, wozu Verminderung derjenigen mit zerstreuten Chromosomen parallel verläuft. Dies bedeutet, dass auch in den letztgenannten Zellen die Kernrekonstruktion aus den Chromosomen langsam vor sich gehen kann.



Fig. 10. Versuch III. Beobachtung nach 33 Stunden. Ein abnormes Endstadium der heterotypischen Teilung; die Kernrekonstruktion verzögert. 38 und 34 Chromosomen in den einzelnen Zellen. Vergr. 940.

Fig. 11. Versuch III. Beobachtung nach 147 Stunden. Dieselbe Erklärung wie in Fig. 10. 35 und 37 Chromosomen. Vergr. 940.

Fig. 12. Versuch III. Beobachtung nach 147 Stunden. Dieselbe Erklärung wie in Fig. 10. Längsspaltung der einzelnen homologen Chromosomen ist sichtbar. 42 Chromosomen. Vergr. 940.

Fig. 13. Metaphase der generativen Kernteilung in einem diploiden Pollenkorn. Paarweise Gruppierung oder gemitähnliche Vereinigung der homologen Chromosomen. Vergr. 940.

In den Materialien, die nach 33, 55 oder 147 Stunden beobachtet wurden, haben wir oft Figuren getroffen, aus denen man bei flüchtiger Untersuchung an die Metaphase der homöotypischen Teilung dieser Zellen schliessen möchte (Fig. 10, 11, 12). Die Chromosomenzahl in beiden Schwesterzellen ist nicht immer gleich 36; einige Abweichungen von dieser Norm sind nicht ausgeschlossen. Die Längsspaltung kann man in einigen Chromosomen bemerken (Fig. 11, 12). In Wirklichkeit stellt aber diese Teilungsfigur nicht die homöotypische Metaphase dar, weil Lage und Form der Chromosomen in der Kernplatte der durch Wärme beeinflussten zweiten Teilung sich ganz anders verhalten (Fig. 4). Das Stadium dieser Zellen entspricht eher der Interkinese, wo die normale Kernrekonstruktion verzögert, die Scheidewandbildung, aber unabhängig davon vollendet wird. In solchen Dyadenzellen werden die vollständig ruhenden Kerne wahrscheinlich bald rekonstruiert, und die zweite Kernteilung wird nicht mehr stattfinden.⁽¹⁾ Wir haben in den weiteren Beobachtungen nie neu stattfindende homöotypische Kernteilung konstatiert.

VERSUCH IV.

9-10/XII 1925.

Temperatur 30°C, Wirkungsdauer 22 Stunden.

Sofortige Beobachtung:

Die Chromosomen, die in der Metaphase der ersten sowie zweiten Teilung abnorm gruppiert sind, fangen an zu degenerieren. Die Kerne in der aktiven Teilungskinetik werden durch die Wärme besonders stark beeinflusst und zwar geschädigt.

Die Beobachtung nach 92 stündigem Verweilen im Korridor:

In den Tetradenzellen bemerkt man degenerierte Kerne oder Karyosubstanzen, aber nicht mehr die zerstreuten Chromosomen. In den Dyadenzellen bleiben dagegen noch die zerstreuten Chromosomen, wobei es in der einen Tochterzelle buchstäblich der Fall ist, während in der anderen ein ruhender Kern schon rekonstruiert ist (Fig. 14). Aus dieser Tatsache kann man schliessen, dass die Rekonstruktion nicht immer in gleicher Geschwindigkeit in den Tochterzellen fortschreitet.

VERSUCH V.

6/XII 1925.

Temperatur 40°C, Wirkungsdauer 6 Stunden.

Alle Blumenknospen gingen zugrunde.

(1) Vgl. KIHARA (1924) bei Weizen-Roggen-Bastard, und besonders BELLING (1925) bei *Uvularia*.

VERSUCH VI.

Während mehreren Tagen wurden die Pflanzen zur Kontrolle stets im Korridor aufbewahrt.

Die erste sowie zweite Teilung verlaufen ganz gleich normal, wie bei den wildwachsenden Materialien.

Es unterliegt wohl keinem Zweifel mehr, dass die oben geschilderten Anomalien und Unregelmässigkeiten der Reduktionsteilung in der durch die höhere Temperatur beeinflussten Pollenmutterzellen die Abweichung der Chromosomenzahl in den Pollenkörnern verursachen können. Da es sehr kompliziert und nicht möglich ist, alle Fälle der abnormen Teilungsmodi zur Entstehung solcher abnormen Pollenkörner zu nennen, so möchten wir uns darauf beschränken, die wichtigsten und wahrscheinlichsten Fälle wie folgt zusammenfassen:

1. Durch die unregelmässige Verteilung der homologen Chromosomen an den beiden Polen in der heterotypischen Kernteilung der Pollenmutterzellen werden Zellen gebildet, aus denen Pollenkörner mit abweichenden Chromosomenzahlen entstehen können (non-disjunction, non-conjunction, detachment.)⁽¹⁾

2. Die Teilungskinetik der heterotypischen Teilung wird gestört und die schon längsweise gespaltenen Chromosomen zerstreuen sich während ziemlich langer Zeit in den Tochterzellen. Nach einiger Zeit treten die interkinetischen Kerne, im Gegensatz zum normalen Falle, in den vollständigen Ruhezustand. Aus solchen Dyadenzellen werden wahrscheinlich direkt die Pollenkörner erzeugt, die meistens die Chromosomen in diploider Anzahl beherbergen. Also hier Ausbleiben der homöotypischen Kernteilung! (non-division). Die Vermutung, dass die Verdoppelung der Chromosomenzahl oft durch den interkinetischen Kernzustand bedingt werden könne, ist schon früher durch die Untersuchung der chloralisierten somatischen Zellen wahrscheinlich gemacht worden.⁽²⁾

3. Durch die einzentrische Rekonstruktion eines Riesenkernes aus allen Chromosomen und durch Fehlen der Zellteilung in der ersten Teilung entsteht eine Riesenzelle (eine Art von non-reduction), aus der direkt oder durch eine nochmalige Teilung diploide oder unter Umständen

(1) BELLING (1925, S. 245-246).

(2) SAKAMURA (1920, S. 73-75, 187).

tetraploide Pollenkörner abgeleitet werden dürften.

4. Durch die unregelmässige Verteilung der Längshälften der Chromosomen auf die Tochterzellen der homöotypischen Teilung, die bei irriger Wanderung der schon getrennten oder noch vereinigt bleibenden Längshälften nach Polen stattfinden kann, entstehen ungleich chromosomige Tetradenzellen. Die verkürzten Chromosomen verweilen ziemlich lange als solche in den Tochterzellen, was uns gestattet, die Längsspaltung einiger Chromosomen sicher festzustellen. Aus je einem solchen gespaltenen Chromosom werden zwei Chromosomen in den nachherigen Kernteilungen aufzutreten erwartet.

5. Die abnorme Scheidewandbildung in der ersten sowie zweiten Teilung, die durch Einschnürung des Cytoplasmakörpers oder durch das zentripetale Wachstum des inneren Teils der Membran der Pollenmutterzelle ausgeführt wird, begünstigt die Entstehung der ungleich grossen Tochterzellen mit abweichenden Chromosomenzahlen. Wenn solche Scheidewandbildung unvollständig aufhört, so entstehen die grossen Zellen von unregelmässigen Formen.

6. Aus den oben genannten Möglichkeiten kann man schliessen, dass die Pollenkörner mit verschiedenen Chromosomenzahlen sich experimentell erzeugen lassen. Deren Fertilität muss natürlich geprüft werden.

Kernteilung bei der Bildung der generativen Zellen in den jungen Pollenkörnern⁽¹⁾

Um den oben erwähnten Schluss zu bestätigen und das Vorhandensein und die Lebenstätigkeit der abnorm grossen Pollenkörner zu prüfen, haben wir zunächst die generative Kernteilung untersucht.

Die aus den Kontrollpflanzen herstammenden normalen Pollenkörner weisen im Teilungsstadium gleichmässige Grösse und Form auf, während bei den experimentell behandelten Materialien eine grosse Variation der Grösse und Form der Pollen vorkommt, z. B. in Blumen, welche aus einer Pflanze⁽²⁾ von Versuch III (30°C–15 Stunden) entnommen wurden, fanden sich folgende Variationen:

(1) Der Kürze des Ausdruckes wegen möchten wir in den folgenden Zeilen diese Kernteilung einfach als „generative Kernteilung“ bezeichnen.

(2) Die Kontroll- und Versuchspflanzen waren schon damals ins Gewächshaus verbracht worden.

TABELLE I

13-19/XII 1925.

Blume (von oben)	Anthere	grössere Pollen	abortive Pollen	Pollen von abnormen Formen
I	alle	—	—	—
II	a	—	—	—
	b	—	—	—
	c	+	+	—
	d	+	+	+
	e	+	+++	—
	f	+++	+	+++
III	a	—	—	—
	b	—	—	—
	c	++	—	—
	d	++	—	—
	e	+++	+	—
	f	+++	+	+
IV	alle	—	—	—

— 0, + 0-25%, ++ 25-50%, +++ 50-75%.

Selbst in ein und derselben Pflanze nur in bestimmten Blumen (I und II) ist solche Variation bemerklich, aber in den anderen (I und IV) und auch in einigen Antheren der durch die Wärme beeinflussten Blumen treten die Pollen gleich gross und gleichförmig auf und zeigen dabei normalen Zustand.

Die generative Kernteilung beginnt viel früher in den grösseren Pollenkörnern als in den kleineren, was auch von BELLING (1925) bei *Uvularia* konstatiert wurde. Sowohl in den kleineren als in grösseren Pollenkörnern schickt sich der Kern früher oder später zur Teilung an, abgesehen von nur wenigen Ausnahmen, wo Leerheit oder Degeneration des Plasmahalts vorkommt. Die Einschnürung der Chromosomen kann man in der Metaphase ersehen.⁽¹⁾ Die Teilung nimmt ganz normalen Verlauf und je eine generative Zelle wird in den meisten Fällen differenziert gebildet. Die Chromosomenzahl, die in der Metaphase bestimmt werden kann, variiert zugleich mit dem Grössenunterschied der Pollenkörner; d. h. normale oder von Haploidie abweichende Zahlen sind zu finden (Fig. 13, 15, 16, 17). Auch in den hypochromosomigen Zellen findet ebenso wohl Kernteilung statt.

(1) Auch bei *Uvularia* (BELLING, 1925).



Fig. 14. Versuch III. Beobachtung nach 92 Stunden. Die Erklärung ist wie in Fig. 10 und 11. In der einen Zelle sind die Chromosomen noch zerstreut, aber in der anderen ist der Kern schon in Ruhe eingetreten. Vergr. 825.

Fig. 15 u. 16. Metaphase der generativen Kernteilung in einem hypochromosomigen Pollenkorn. 30 Chromosomen (in Fig. 15). 29 Chromosomen (in Fig. 16). Vergr. 2120.

Fig. 17. Anaphasische Chromosomen in der generativen Kernteilung in einem hyperchromosomigen Pollenkorn. 54 Chromosomen. Vergr. 2120.

Fig. 18. Einige Chromosomen in der Anaphase der generativen Kernteilung in einem hyperchromosomigen Pollenkorn. Paarweise Anordnung der homologen Chromosomen. Vergr. 2120.

Sehr merkwürdig ist die Gruppierung oder oft die Vereinigung der einzelnen homologen Chromosomen, die an die Gemini- oder Vierergruppenbildung erinnern kann. Diese Erscheinung ist zumal in den diploiden Pollenkörnern auffällig (Fig. 13). Auch in der Anaphase liegen die Homologen paarweise nebeneinander (Fig. 18). BELLING (1925) fand ähnliche paarweise Lagerung der homologen Chromosomen in Kernteilung der diploiden Pollenkörner von *Uvularia*, die durch die niedere Temperatur hervorgebracht wurden, und er hat das auf das Fehlen der homöotypischen Teilung zurückgeführt. Auch in unserem Falle mit *Gagea* kann seine Auffassung wohl akzeptiert werden, wenn wir den vollständigen Ruhezustand der Interkinese der durch die Wärme beeinflussten Pollenmutterzellen annehmen werden.

Aus den oben geschilderten Tatsachen sind wir berechtigt zu schliessen, dass in den experimentell geschaffenen Pollenkörner von sehr variabler Grösse, d. h. mit normalen oder abweichenden Chromosomenzahlen, die generative Kernteilung ganz normal stattfinden kann. Auch die reichliche Menge von Plasmahalt spricht durchaus nicht gegen ebenso erfolgreiches Weiterleben, wie bei den normalen.

Morphologische Eigenschaften der reifen Pollenkörner

Die Untersuchung wurde an den reifen Pollenkörnern ausgeführt, die von den ins Gewächshaus überbrachten Pflanzen zur Blütezeit entnommen wurden. Ein Teil davon wurde auch zu weiteren Bestäubungsversuchen verwendet. Um die Grösse des Pollens zu messen, wurde 12 proz. Rohrzuckerlösung als Mediumflüssigkeit gebraucht. Ob diese Konzentration in osmotischer Hinsicht die geeignetste ist, kann man nicht bestimmt sagen. Da die Resultate der Messung an den normalen Pollenkörnern in dieser Lösung und auf dem 1 proz. Agar-Boden (12 proz. Rohrzucker) ganz miteinander übereinstimmten, so haben wir die Rohrzuckerlösung von dieser Konzentration als für unsere Zwecke brauchbar betrachtet. Nun möchten wir einige Durchschnittswerte der Pollengrösse aus den Protokollen wiedergeben.⁽¹⁾

(1) Es gibt natürlich eine kontinuierliche Variation, was uns unmöglich macht, die Pollenkörner nach ihrer Grösse exakt zu klassifizieren. Nur plasmahaltige, ellipsoidische oder kugelförmige Pollen wurden gemessen. Der Versuch wurde am 2 Feb. 1926 gemacht.

A		$61.2 \times 48.5\mu$ ($67 \times 51 \mu - 56 \times 46\mu$)
B	I	$72.6 \times 61.8\mu$ ($81 \times 59 \mu - 70 \times 57\mu$)
	II	$53.0 \times 44.8\mu$ ($60 \times 51 \mu - 43 \times 35\mu$)
C		$79.9 \times 67.7\mu$ ($96 \times 61 \mu - 67 \times 48\mu$)
D		$87.0 \times 82.6\mu$ ($122 \times 110\mu - 51 \times 37\mu$)

- A: aus einer Anthere einer Kontrollpflanze.
 B: aus einer Anthere einer Pflanze von Versuch III (30°C-15 Stunden). I, grössere Pollen. II, kleinere Pollen.
 C: aus einer Anthere einer Pflanze von Versuch III. Nur grössere Pollen wurden zur Messung ausgewählt.
 D: aus einer Pflanze, die 8 Stunden im Thermostat von 30°C, 16 Stunden im Korridor, dann 7 Stunden wieder im Thermostat von 30°C behalten worden ist. Die Pollen sind zum grössten Teil grösser; wenige sind abortiv.

Die reifen Pollenkörner der Kontrollpflanzen sind gleichförmig ellipsoidisch und von gleicher Grösse (Taf. III, Mikrophoto. 2). Der Durchschnittswert ihrer Grösse, in 12 proz. Rohrzuckerlösung gemessen, beträgt $61.2 \times 4.85\mu$. Dagegen zeigen bei den experimentell durch die Wärme beeinflussten oder dauernd im Gewächshause kultivierten *Gagea*-Pflanzen die reifen Pollenkörner eine grosse Variation in Grösse und Form (Taf. III, Mikrophoto 3). Das Volumen der grösseren Pollen ist meistens ungefähr zweimal so gross wie bei den normalen Pollen. Wird angenommen, dass zwischen der Chromosomenzahl und dem Volumen des Pollenkorns eine bestimmte Relation bestehe, so sind unsere grösseren Pollenkörner fast ausschliesslich als diploid zu betrachten. Die extreme

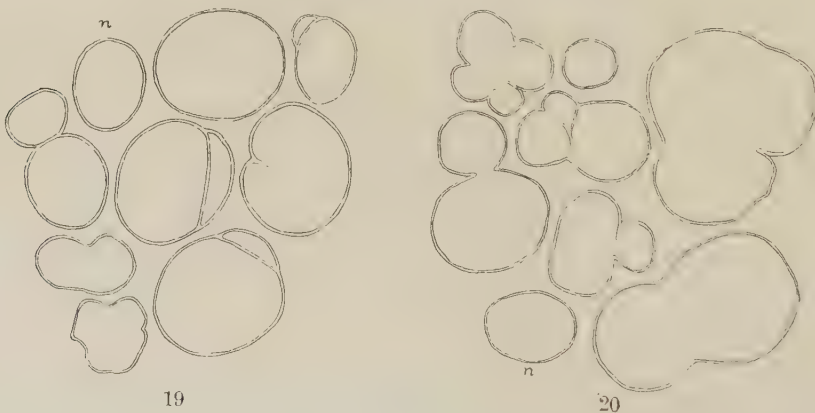


Fig. 19. Abnorme reife Pollenkörner aus der Pflanze, die dauernd im Gewächshause kultiviert worden war. n, normaler Pollenkorn. Vergr. 205.

Fig. 20. Abnorme reife Pollenkörner aus der Pflanze von Versuch I. n, normaler Pollenkorn. Vergr. 205.

Grösse beträgt $122 \times 110 \mu$. Das morphologische Aussehen des Plasma-inhalts dieser grösseren Pollenkörner ist ganz normal. Ausgenommen von denjenigen von unregelmässigen Formen, enthalten die Pollenkörner stets eine generative Zelle und einen vegetativen Kern. Was die Anomalien der Form des Pollenkorns betrifft, so sprechen die Abbildungen wohl besser als viele Worte (Fig. 19, 20).

Die morphologische Heterogenität der Pollenkörner ist je nach den Versuchspflanzen oder den Antheren verschieden, was aus den folgenden Tabellen ersichtlich ist.⁽¹⁾

TABELLE II

20/I 1926. Das Material wurde aus einer Blume einer Pflanze von Versuch I (25°C-15 Stunden) entnommen.

Anthere	grössere Pollen	abortive Pollen	Pollen von abnormen Formen
a	—	+	+
b	+	+++	+
c	+	++	++
d	+++	+	+
e	++	+	++

— 0, + 0-25%, ++ 25-50%, +++ 50-75%.

TABELLE III

22/I 1926. Das Material wurde aus einer Blume einer Pflanze entnommen, die seit Oktober 1925 dauernd im Gewächshause (13°-31°C) kultiviert worden war.

Anthere	grössere Pollen	abortive Pollen	Pollen von abnormen Formen
a	+	+	—
b	++	++	+
c	++	+	—

(1) Die Beobachtung wurde auf Zucker-Agar-Boden gemacht.

TABELLE IV

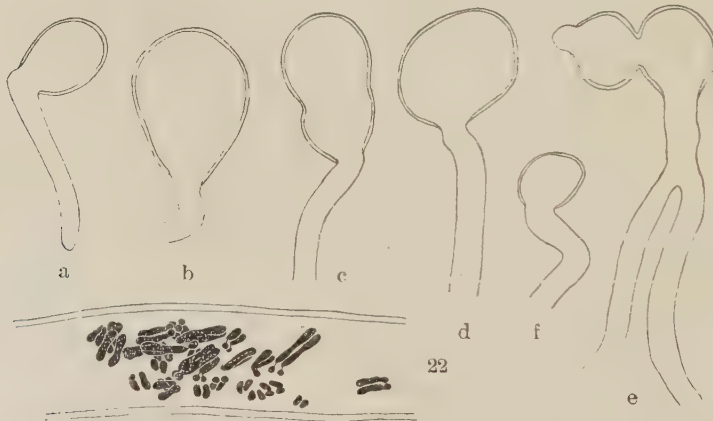
28/I 1926. Das Material wurde aus einer Blume einer Pflanze von Versuch III (30°C-15 Stunden) entnommen.

Anthere	grössere Pollen	abortive Pollen	Pollen von abnormen Formen
a	++	+	—
b	+++	+	++
c	+++	—	++
d	+++	+	+
e	+	+	—

Keimversuche der Pollenkörner

Um zu prüfen, ob die künstlich hervorgebrachten abnorm chromosomigen Pollenkörner keimfähig sind, haben wir Versuche über die künstliche Pollenkeimung angestellt. Die nicht verdorbenen Pollen wurden, zur Blütenzeit im Gewächshause, auf dem Zucker-Agar-Boden gesät, der in der PETRI-Schale⁽¹⁾ von 4.5 cm Durchmesser hergestellt worden war.

21



22

Fig. 21. Keimende Pollen auf Zucker-Agar-Boden. Pollen aus den Pflanzen von Versuch III. a, normaler Pollen. b, c, d, e, hyperchromosomig. f, hypochromosomig. Vergr. 205.

Fig. 22. Kernteilung im Pollenschlauch aus einem hypochromosomigen Pollen. Etwa 29 Chromosomen. Vergr. 1060.

(1) Dieses Glas ist nach unserer Prüfung alkalienfrei.

VERSUCH VII.

25/I 1926. Das Material wurde aus den Pflanzen von Versuch III (30°C-15 Stunden) entnommen.

Keimboden $\left\{ \begin{array}{ll} \text{Agar-Agar} & 0.5 \text{ g} \\ \text{Rübenzucker} & 6.0 \text{ g} \\ \text{Umdestilliertes Wasser} & 50.0 \text{ ccm} \\ \text{pH}=6.5 \end{array} \right.$

Anthere	Pollengrösse	Keimung			
		nach 1 St. 20°-18°	nach 2 St. 20°-18°	nach 2½ St. 30°	nach 20 St. 30°
A	grösser	—	—	+	+++
	normal u. kleiner	+	++	+++	+++
B	grösser	—	—	+	++
	normal u. kleiner	++	++	+++	+++
C	grösser	—	—	+	++
	normal u. kleiner	+	++	+++	+++

— 0, + 0-25%, ++ 25-50%, +++ 50-100%.

Die normalen und kleineren Pollenkörner keimten nach 2 Stunden in Zimmertemperatur (20°-18°C) ziemlich gut aus, aber die grösseren nicht. Nach 1/2 Stunde im Thermostat von 30°C platzten viele von jenen an der Spitze des Keimschlauchs, und fingen einige von diesen an auszukeimen. Nach 20 Stunden keimten die grösseren fast ebenso gut aus, wie die kleineren (Fig. 21).

VERSUCH VIII.

28/I 1926. Das Material wurde aus einer Anthere einer Pflanze von Versuch III (30°C-15 Stunden) entnommen.

Keimboden	Agar-Agar	1 g
	Rohrzucker, MERCK extra pure	12 g
	Umdestilliertes Wasser	100 ccm

Durch den Zusatz von N/10 HCl wurden Keimböden von verschiedenen H-Ionenkonzentrationen hergestellt.

Der Versuch wurde im Thermostat von 30°C ausgeführt.

pH	Pollengrösse	Keimung			
		nach $\frac{1}{2}$ St.	nach 1 St.	nach $1\frac{1}{2}$ St.	nach 18 St.
6.2	grösser	—	+	++	+++
	normal u. kleiner	+	++	+++	+++
6.0	grösser	+	++	+++	+++
	normal u. kleiner	+	++	+++	+++
5.5	grösser	—	+	++	+++
	normal u. kleiner	+	++	+++	+++
4.9	grösser	—	—	+	++
	normal u. kleiner	+	+	++	+++

Von diesen Keimböden gab derjenige von pH 6.0 den besten Erfolg für das Auskeimen sowohl der grösseren wie der normalen oder kleineren Pollenkörner, und jene keimten ebenso gut aus, wie diese (Mikrophoto. 3).⁽¹⁾ Auf den Böden von anderen H-Ionenkonzentrationen zeigten die grösseren Pollen die Tendenz sich beim Auskeimen etwas zu verspäten, obwohl nach längerem Zeitverlauf (nach 18 Stunden) kein solcher Unterschied mehr zu bemerken war.

Zum Beweis dafür, dass auch die hypochromosomigen Pollenkörner

(1) Die keimenden Pollen wurden nur deswegen in den früheren Stadien des Auskeimens photographiert, weil die Verwirrung der ausgewachsenen Pollenschläuche die klare Beobachtung erschwert. Nach mehreren Stunden erreichten die Pollenschläuche, die in den Photographien sichtbar sind, ungeheure Längen.

gut auskeimen können (Fig. 21f), möchten wir eine Photographie (Mikrophoto. 6) und eine Abbildung (Fig. 22) der Kernteilung im mit Essigkarmin gefärbten Pollenschlauch (pH 6.0, nach 18 Stunden) wiedergeben, wo die Chromosomenzahl sicher weniger als 36 (ungefähr 29) beträgt, wenn sie auch nicht ganz genau bestimmt werden kann.

VERSUCH IX.

2/II 1926. Das Material wurde aus den Pflanzen entnommen, die 8 Stunden im Thermostat von 30°C, 16 Stunden im Korridor, dann wieder 7 Stunden im Thermostat von 30°C behalten worden waren. Die Pollenkörner aus diesen Pflanzen waren meistens grösser.

Keimboden	Agar-Agar	0.5 g
	Rohrzucker, MERCK extra pure	6.0 g
	Umdestilliertes Wasser	50.0 ccm

Durch den Zusatz einer bestimmten Menge von N/10 HCl wurde die Reaktion zu pH 5.9 reguliert.

Der Versuch wurde im Thermostat von 30°C ausgeführt.

Polléngösse	Keimung		
	nach 1 St.	nach 2 St.	nach 18 St.
grösser	+	+	+++
normal u. kleiner	—	—	+++

Nach 2 Stunden keimten nur die grösseren Pollen aus, aber die normalen und kleineren gar nicht (Mikrophoto. 4, 5). Erst nach 18 Stunden bemerkte man keinen Unterschied des Keimungsgrades mehr.

Aus diesem Versuche kann man schliessen, dass die optimalen Keimungsbedingungen je nach den Pollengrössen verschieden sind, und die grösseren Pollenkörner unter günstigen Bedingungen früher auskeimen und üppiger wachsen können als die normalen oder kleineren.

Aus den Keimversuchen kann man auch erkennen, dass die Pollenkörner von normaler und von abnormer Grösse gleich keimfähig sind, und diese ebenso gutes Wachstum an ihren Keimschläuchen aufweisen wie jene.

Dass die grösseren Pollen aber etwas später auskeimen und etwas höherer Temperatur bedürfen als die kleineren, ist in unseren Versuchen eine allgemeine Tendenz. TISCHLER (1925 a u. 1925 b) bestätigte die

erstgenannten Tatsache bei anderen Pflanzen. Er ist der Meinung, dass die Grösse der Kernoberfläche für die Frage des Auskeimens der Pollenkörner von entscheidendem Einfluss ist, und er nimmt an, „dass von der Kernoberfläche gewisse Stoffe sezerniert werden, die die Umsetzung der „Dottersubstanzen“ und das Auskeimen des Pollens erst ermöglichen und vielleicht erst die dazu nötigen Enzyme zu aktivieren vermögen.“⁽¹⁾

Ob das Ausbleiben oder die Verzögerung des Auskeimens aber nicht das Nichtkeimen unserer Riesenpollen, gestützt auf die von TISCHLER aufgestellte Arbeitshypothese erklärbar ist, mag noch dahingestellt bleiben. Nur darauf möchten wir hier aufmerksam machen, dass die Bedingungen wie z. B. Temperatur, H-Ionenkonzentration usw., die das Keimmedium beherrschen, hierbei wenigstens in unseren Versuchen eine grosse Rolle spielen. Darüber wissen wir aber noch wenig und müssen daher auf eine eingehende Erörterung verzichten.

Die Pollenkörner von heterogener Grösse wurden durch künstliche Bestäubung auf die Narben übertragen, und wir haben dadurch etwa zweitausend Samen bekommen. Die Resultate der weiteren Untersuchungen mit den Keimlingen aus diesen Samen werden später mitgeteilt werden.

Allgemeine Erörterung

Die Möglichkeiten, wodurch die Polyploidie entstehen kann, wurden vor einigen Jahren (1920) von dem einen von uns (SAKA.) zusammenfassend angegeben. Seitdem wurden viele andere neue Möglichkeiten von mehreren Forschern gezeigt und einige davon wirklich experimentell bestätigt. Unter diesen Möglichkeiten wollen wir nun besonders denjenigen Fall in Betracht ziehen, wo die Entstehung von Gameten mit abweichenden Chromosomenzahlen für die Vorstufe der polyploiden Veränderung sich geltend macht. Wenn diese Zahlen anders als n -ploid sind, so wäre es natürlich nicht schwierig anzunehmen, dass daraus nicht- n -ploidie Beziehung entstehen könnten.

Die Frage, ob die Veränderung der Chromosomenzahl immer diejenige der äusseren Merkmale korrelativ begleiten kann, ist nicht leicht zu beantworten. Wir wollen hier diese Frage nicht eingehend besprechen, sondern uns nur darauf beschränken, den Verlauf der Entstehung der Polyploidie oder der anderen Abweichungen der Chromosomenzahl zu erörtern. Es ist aber schon eine bekannte Tatsache,

(1) TISCHLER (1925 a, S. 164).

dass die Veränderung der Chromosomenzahl gleichzeitig mit der Mutation auftritt, und dies in neuerer Zeit besonders durch die ausgezeichneten Arbeiten von BLAKESLEE und seiner Mitarbeiter⁽¹⁾ bei *Datura* bewiesen worden.

In der vorliegenden Arbeit wurde genau bestätigt, dass die äusseren Bedingungen die Entstehung der Gameten mit abweichenden Chromosomenzahlen zu veranlassen vermögen, durch deren Befruchtung eine chromosomale Mutation möglicherweise hervorgerufen werden dürfte.⁽²⁾ Falls ein diploides Pollenkorn ein haploides Ei befruchtet, so würde natürlich ein triploider Nachkommen entstehen. In dieser Hinsicht lassen wir die Arbeiten von DE MOL an *Hyacinthus* nicht ausser acht. Wie schon erwähnt, hat er auf den Hyacinthen, die aus unreifen Zwiebeln im Gewächshause gezogen waren, diploide Pollenkörner (of duplicate generative nuclei) gefunden und damit die Narben bestäubt. Dies brachte ihm in der Tat die Entstehung von drei triploiden Keimlingen. Als die Hauptursache des Entstehens solcher abnormer Pollenkörner hat er den unreifen Zustand angeführt, während er aber geneigt ist, die Wirkung des nachherigen Erwärmens des Pflanzkörpers anzuzweifeln. Betreffs der Frage, wann solche Verdoppelung der Chromosomenzahl im Pollenkörner stattfindet, äusserte er sich, dass die Synhaploidie nach der generativen Kernteilung geschehen könnte. Die Reduktionsteilung soll seiner Meinung nach normal vor sich gehen, was allerdings von ihm nicht untersucht wurde.

Obwohl wir in verschiedenen Punkten seiner Behauptung, z. B. der überwiegende Rolle der äusseren Bedingungen zur Entstehung von Polyploidie sowie der Mutanten, ihm zustimmen, so gehen wir, darin nicht einig, wenn er behauptet, dass "instead of chemical or physical stimuli physiological stimuli must act etc." (S. 253).

Bei unserem Material *Gagea lutea* wurde die abnorme Reduktionsteilung als die Hauptursache zur Entstehung der Pollen mit abweichenden Chromosomenzahlen bestätigt, und solche Anomalie konnte dabei ohne Zweifel durch rein physikalischen Reiz, nämlich durch die Wärme, leicht hervorgerufen werden. Da wir die Reduktionsteilung der Pollenmutterzellen von *Hyacinthus* unter diesen Bedingungen ebenso wenig wie DE MOL untersucht haben, so sind wir nicht berechtigt weitere Erörterungen darüber zu machen. Es sei aber gestattet, die Beziehung zwischen

(1) BLAKESLEE (1921), BLAKESLEE und BELLING (1924).

(2) Diese Möglichkeit ist schon durch die Arbeit von WETTSTEIN (1924) wahrscheinlich gemacht worden.

der Entstehung der Polyploidie und den äusseren Bedingungen noch einigermassen in allgemeine Erwägung zu ziehen.

Wie schon in der Einleitung erwähnt, gehört *Gagea lutea* samt *Hyacinthus*, *Narcissus* u. a. zu derjenigen Pflanzengruppe, die zur kühlen oder kalten Zeit die Pollenmutterzellen in die Teilung schickt. Werden solche Pflanzen künstlich so behandelt, wie bei unseren Versuchen, so wäre er nicht unmöglich, dass auch bei ihnen die abnormen Gameten bzw. Nachkommen mit abweichenden Chromosomenzahlen in derselben Weise entstehen könnten. Ja selbst bei *Hyacinthus* wäre es nicht ausgeschlossen, dass durch diese künstliche physikalische Ursache, eine ganz andere als die von DE MOL angenommene, dasselbe Resultat erreicht werden könnte. Aus dieser Erwägung geht hervor, dass die chromosomale Mutation im allgemeinen viel leichter experimentell erzeugt werden kann, als man bisher geglaubt hat, wenn die physiologischen Eigentümlichkeiten der Pflanzen selbst sowie die äussere Bedingungen und zwar ihre Kombination genau vorher untersucht werden. Während bei einigen Pflanzen die höhere Temperatur wohl mässig in oben erwähntem Sinne einwirkt, muss man für andere Pflanzen eher die niedere Temperatur⁽¹⁾ oder einen anderen physikalischen oder chemischen Reiz⁽²⁾ anwenden, damit dasselbe Resultat erreicht wird.

Bei dieser Gelegenheit wollen wir nicht versäumen, das Problem der Pollensterilität ein wenig zu berühren.

Die sterilen Pollenkörner werden oft in Bastard-, parthenogenetischen Pflanzen oder in denjenigen, die seit langem vegetativ vermehrt worden sind, infolge der abnormen Reduktionsteilung der Pollenmutterzellen erzeugt. Dazu kommen noch diejenigen Pflanzen, bei denen die Pollensterilität leicht durch Klima oder andere äussere Bedingungen verursacht wird. Der letztgenannte Fall ist durch unseren Untersuchungen mit *Gagea* und *Solanum tuberosum* wohl konstatiert worden. Wir dürfen also die Pollensterilität von dieser Art und die Entstehung der Polyploidie oder anderer Beziehung der Chromosomenzahl auf qualitativ dieselbe, aber quantitativ verschiedene äussere Ursache zurückführen. Je nach den Eigentümlichkeiten der Pflanzen ergeben sich aber ganz verschiedene Phänomene; z. B. werden bei der Kartoffelpflanze fertile haploide oder sterile Pollenkörner und bei *Gagea lutea* fertile haploide, fertile oder sterile Pollenkörner gleicherweise durch die höhere Temperatur erzeugt.⁽³⁾

(1) Wahrscheinlich bei *Uvularia* (BELLING, 1925).

(2) Z. B. bei Moosen (WETTSTEIN, 1924).

(3) Über die Pollensterilität bei Kultur-, besonders Gewächshauspflanzen ist schon in der Einleitung eine kurze Besprechung enthalten.

Nun ist es nicht mehr zweifelhaft, dass die Pollensterilität nicht nur auf die Bastardpflanzen beschränkt ist. Deshalb wäre es schon logisch unrichtig, wenn man solche Anomalien der Reduktionsteilung oder die Pollensterilität stets als Beweis für die Bastardnatur ansehen wollte; doch wollen wir mit der Erörterung der Bastardnatur der in Frage kommenden Pflanzen oder Tiere, z. B. von *Oenothera*, *Drosophila* u. a.⁽¹⁾ uns weiter nicht beschäftigen.

Zusammenfassung

1. Es gelang, Pollenkörner mit abweichenden Chromosomenzahlen bei *Gayea lutea* experimentell durch den Einfluss höherer Temperatur entstehen zu lassen, die auf dem künstlichen Keimboden wohl auskeimen können. Durch die Befruchtung mit solchen Pollenkörnern dürften polyploide oder nicht-polyploide Pflanzen entstehen.

2. Die Möglichkeit ist gross, dass die chromosomale oder unter Umständen auch die die Veränderung äusserer Merkmale begleitende Mutation viel leichter experimentell erzeugt werden könne, als man bisher geglaubt hat, wenn die Beziehung zwischen den physiologischen Eigentümlichkeiten der Pflanzen selbst und den äusseren Bedingungen genau berücksichtigt wird.

3. Die Entstehung von solchen abnormen Pollenkörnern ist dabei auf die durch die äusseren Faktoren hervorgerufenen mässigen Anomalien der Reduktionsteilung der Pollenmutterzellen zurückzuführen.

4. Falls die Wärme zu stark auf die Pollenmutterzellen einwirkt, so entstehen infolge der übermässig hervorgerufenen Anomalien der Reduktionsteilung sterile Pollen.

5. Wollte man die Anomalien der Reduktionsteilung oder die Pollensterilität stets als Beweis für Bastardnatur verstehen, so wäre das schon logisch unrichtig. Die Pollensterilität infolge der abnormen Reduktionsteilung ist nicht nur auf die Bastardpflanzen beschränkt, sondern kann auch durch Klima oder andere äussere Bedingungen bei einigen Pflanzen verursacht werden.

Die Anregung für die vorliegende Untersuchung wurde mir vor etwa zehn Jahren von Herrn Prof. Dr. K. FUJII in Tokyo gegeben, als ich noch in seinem Laboratorium arbeitete. Da es meinem Schüler und

(1) JEFFREY und HICKS (1925).

mir jetzt teilweise gelang, diese Studien erfolgreich durchzuführen, möchte ich die Gelegenheit nicht vorbegehen lassen, ohne meinem verehrten Lehrer nochmals für seine liebenswürdige Aufmunterung bestens zu danken.

SAKAMURA.

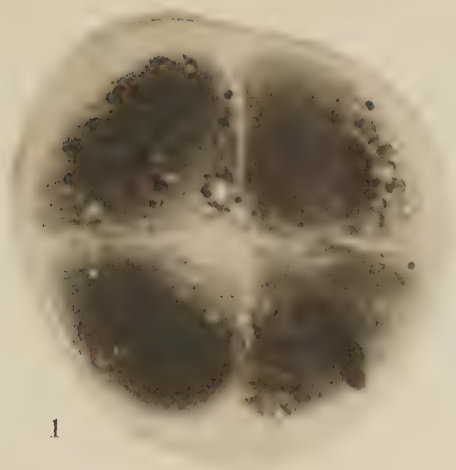
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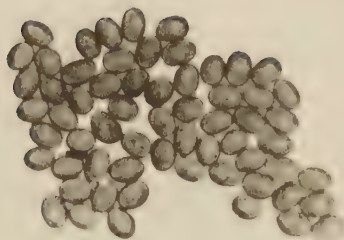
Figurenerklärung der Tafel III

Mikrophotographien der Tetradenzellen und der Pollenkörner von *Gagea lutea*. Vergrößerung: 1000 (1). 57 (2-5). 1600 (6).

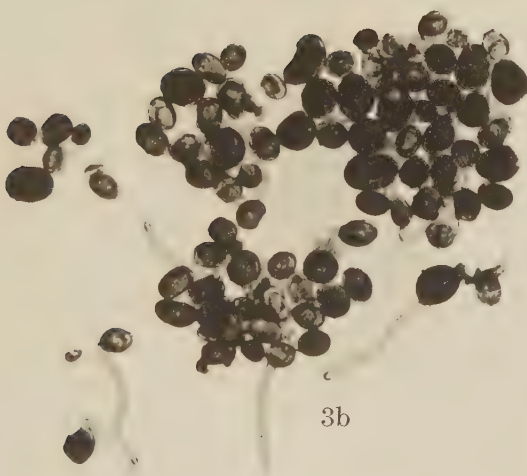
1. Dieselbe Tetradenzellen, die in Fig. 8 abgebildet sind.
 2. Normale reife Pollenkörner. Auf Agar-Boden.
 3. Versuch VIII. Keimung der Pollenkörner von verschiedenen Grössen und Formen auf Agar-Boden. a, nach 1/2 Stunde. Ein grösserer Pollen in der Mitte der Figur ausgekeimt. b, c, d, nach 1 Stunde. Sowohl grössere wie normale oder kleinere Pollen sind ausgekeimt.
 4. Versuch IX. Pollenkeimung auf Agar-Boden. Nach 1/2 Stunde. Ein grösserer Pollen rechts ist ausgekeimt.
 5. Versuch IX. Pollenkeimung auf Agar-Boden. Ein grösserer Pollen ist ausgekeimt, dessen Keimschlauch verzweigt.
 6. Kernteilung des generativen Kernes in Pollenschlauch des hypochromosomigen Pollens, die in Fig. 22 abgebildet ist.
-



1



2



3b



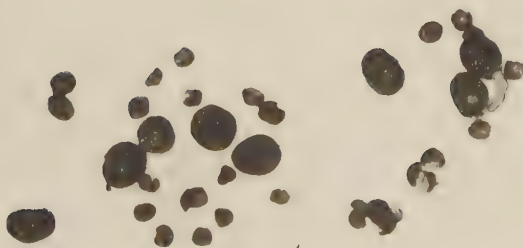
3a



3c



3d



4



6



5



Ueber die Zytokinese bei der Pollentetradenbildung, zugleich weitere Beiträge zur Kenntnis über die Zytokinese im Pflanzenreihe

Von Gihzi YAMAHA

Hierzu Tafel IV-VI

Contributions to Cytology and Genetics from the Department of Plant-
Morphology and of Genetics, Botanical Institute, Faculty of
Science, Tokyo Imperial University, No. 56

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Hinsichtlich der Zytokinese bietet uns die Tetradenteilung in Pollenmutterzellen zwei interessante Fragen dar, nämlich die Simultaneität der Tetradenbildung, und Zytokinese vermittelt Membranleisten („furlowing“), mit denen wir uns hier in erster Linie beschäftigen wollen. Was zunächst die erste Frage betrifft, so ist es längst bekannt, dass bei den Phanerogamen (vgl. GUIGNARD ('82), STRASBURGER ('80), SAMUELSSON ('14) usw.) sowie auch den Archegoniaten zwei Modi der Tetradenbildung verbreitet sind. Bei der simultanen Tetradenbildung, wie sie geläufig als Dikotylen-Typ bezeichnet wird, folgt keine Scheidewandbildung gleich auf die erste oder heterotypische Kernteilung, sondern die Pollenmutterzelle wird erst nach der Ausbildung der vier Enkelkerne simultan in eine Vierergruppe der Zellen (Pollentetrade) geteilt. Demgegenüber bei dem anderen Modus (sog. Monokotylen-Typ) der Tetradenbildung kommt die Pollentetrade durch die sich je an die beiden Karyokinesen der Meiosis anschliessenden zweimaligen Zytokinesen zur Bildung. Auf die Anordnung der vier Pollenzellen in jeder Tetrade hat der in Frage stehende Modus der Tetradenbildung nicht keinen Einfluss. Während nämlich sich jede nach Monokotylen-Typ ausgebildete Pollentetrade im Allgemeinen quadratisch anordnet, hat die simultane Tetradenteilung am häufigsten eine tetraëdrisch angeordnete zur Folge. Die beiden Typen der Tetradenbildung machen sich, wie folgende Zusammenfassung zeigt, bei jeder Pflanzengruppe bemerkbar.

1. Bryophyten. Bei Lebermoosen (vgl. STRASBURGER ('80). FARMER ('94, '95), DAVIS ('99, '01), VAN HOOK ('00), MOORE ('03, '05).

LEWIS ('06), BEER ('06), FARR ('16) usw.) stehen Marchantiales und Jungermanniales auch betreffs der Sporentetradenbildung einander gegenüber. Bei Jungermanniales, so z. B. *Pellia*, *Fossombronia*, *Aneura*, *Scapania*, *Cephalozia*, *Lophocolea*, *Frullaria*, *Symphyogyna* usw. teilt sich die Sporenmutterzelle stets sukzedan, welche sich vierlappig oder tetraëdrisch gestaltet und in der Prophase der ersten Kernteilung der Tetradenbildung eine vierpolige Spindelfigur aufweist. Bei Marchantiales (z. B. *Marchantia*, *Fegatella*, *Plagiochama*, *Fimbriaria* usw.) sowie auch bei Anthocerotales (*Anthoceros*) bildet sich hingegen die Sporentetrade durch die simultane Teilung der Sporenmutterzellen, denen weder die vierlappige Form noch die vierpolige Spindel zukommt. Auch bei dieser Regelmäßigkeit der Tetradenbildungsmodi scheinen aber einige Ausnahmefälle vorzukommen, so z. B. erfährt die Sporenmutterzelle von *Pallavicinia* (*Blyttia*), *Sphaerocarpus* und *Riella*, die alle in Jungermanniales gehören, eine simultane Teilung. Bei *Riccia* (Marchantiales) ist eine Uebergangsform der Tetradenbildung angegeben (s. LEWIS ('06), BEER ('06)), wo die erste Kernteilung von einer unvollständigen Zytokinese begleitet wird (s. unten).

Bei Laubmoosen scheint im Allgemeinen die simultane Tetradenbildung vorzuherrschen, wenn auch die sukzedane Tetradenbildung (z. B. bei *Catharinea* nach ALLEN ('16)) sowie der Uebergangstyp (*Mnium*; *Sphagnum* nach MELIN ('15)) beobachtet werden können (vgl. FARR ('16)).

2. Pteridophyten. Die Tetradenteilung der Sporenmutterzellen von Farnen gehört der Regel nach in den Dikotylentyp. Die Plasmaschranke, welche nach der ersten Kernteilung der Sporenmutterzellen verschiedener Pteridophyten in die Erscheinung zu treten pflegt (vgl. YAMAHARA ('20 a, S. 124)), täuscht eine unvollständige Scheidewandanlage vor, so dass ich sie seinerzeit fälschlich der Spindelsubstanz angereicht habe. Die weitere Beobachtung an den nach Mitochondrialmethoden fixierten Objekten ergibt jedoch, dass die betreffende Plasmaanhäufung nichts anderes als einen Chondriomhaufen (Mitochondrialplatte) darstellt, der als der Rest des in früheren Stadien der Karyokinese den Spindelraum umwallenden „Chondriommantels“ angesehen werden kann, und demzufolge mit der Scheidewandbildung nichts zu tun hat. In dieser Hinsicht führt unsere erneute Beobachtung an den Sporenmutterzellen von *Psilotum* zu demselben Befunde wie dem neuerdings von LEWITSKY ('25) bei *Equisetum* gewonnenen; nur will ich jedoch die Tatsache dahin deuten, wie sich DEVISÉ ('22) schon früher für *Larix* geäußert hat, nämlich dass das Chondriom bei der Zytokinese keine prinzipielle Rolle spielen soll (s. weiter unten). Dafür spricht der Befund, dass der Chondriom-

haufe inmitten des Phragmoplasten nicht auf der Stelle zum Vorschein kommt, sondern gleichzeitig mit der zentripetalen Rückbildung der transitorischen Zellplatte von der Peripherie des Zytoplasmas aus in den Phragmoplasten hinein dringt (s. YAMAHA ('20 a), S. 124, Fig. 10.)

3. Gymnospermen. Wie bei Pteridophyten, wird die Tetradenteilung der Pollenmutterzellen von Gymnospermen im Allgemeinen in simultaner Weise durchgeführt. Als Ausnahmen hierfür ist die sukzedane Teilung angegeben bei *Ceratozamia* (JURÁNYI '82), *Larix* (TIMBERLAKE '00) und *Taxus* (s. TISCHLER '21-'22, S. 205).

4. Angiospermen. Für die geläufig anerkannte Regel, dass sich die Pollentetrade bei Dikotylen durch die simultane Zellteilung, bei Monokotylen durch die sukzedane bildet, wurde bisher häufig auf nicht wenige Ausnahmen aufmerksam gemacht (vgl. FARR ('16), SUESSENGUTH ('21), TISCHLER ('21-'22, S. 205), STENAR ('25, S. 170 ff) usw.). Unter dikotylen Pflanzen werden die sukzedane Tetradenbildung bei folgenden Familien (meist aus Archichlamydeen!) beobachtet: Proteaceen, Aristolochiaceen, Rafflesiaceen, Nyctaginaceen, Nymphaeaceen, Ceratophyllaceen, Anonaceen, Lauraceen, Droseraceen, Passifloraceen, Apocynaceen, Asclepiadaceen. (Die in der Literatur angegebenen verdächtigen Fällen sind von der Liste ausgeschlossen.)

Merkwürdig ist noch, dass die sukzedane Tetradenteilung bei Dikotylen häufig mit der abnormen Reduktionsteilung zusammenkommt, so beispielsweise, bei *Taraxacum*, *Hieracium*, *Mirabilis*, *Lathyrus*, *Houttuynia* usw.

Von denjenigen Monokotylen, deren Pollenmutterzellen sich simultan teilen, treten noch viel mehr als Ausnahmen von der Regel auf, nämlich bei manchen oder so gut wie allen Gattungen aus folgenden Familien oder Unterfamilien:⁽¹⁾ Palmen, Iridaceen, Aloëae (Liliaceen), Orchidaceen und weiter vereinzelte Gattungen von Cyperaceen, Commelinaceen, Juncaceen, Taccaceen, Dioscoreaceen usw.

Nach alledem ist es allerdings denkbar, dass der eine oder andere Typ der Tetradenbildung bis zu einem gewissen Grad für eine bestimmte systematische Stellung der Pflanzen charakteristisch ist und zwar scheint auch hier, wie bei Endosperm bildung, die simultane Teilung den primitiven Typ und die sukzedane den abgeleiteten darzustellen. (vgl. SUESSENGUTH '21, S. 3; TISCHLER '21-'22, S. 201, 203). Beachtenswert ist aber, dass es an einigen extremen Fällen nicht fehlt, wo der Modus der Tetradenbildung bei ein und derselben Gattung oder sogar Art

(1) Vgl. STENAR a. a. O.

verschieden ausfällt. Nach TÄCKHOLM und SÖDERBERG ('18) wird die Pollentetrade bei *Aristolochia Siplo* simultan, bei *Aristolochia clematitis* und *fimbriata* dagegen sukzedan gebildet. Bei *Drosera*- und *Plantago*-Arten (LEVINE ('16), EKSTRAND ('18)) sind weiter beide Typen der Tetradenbildung angegeben. TIMBERLAKE ('00) machte bei *Larix europaea* diesbezüglich auf einen individuellen Unterschied aufmerksam.⁽¹⁾

Ein besonderes Interesse bietet im übrigen der Umstand, dass sich der Zwischen- bzw. Uebergangstyp der Tetradenbildung vorfindet, wobei eine unvollständige Scheidewandbildung gleich nach der ersten Kernteilung eingeschaltet wird (s. oben). Auch bei manchen von uns beobachteten Fällen von simultaner Tetradenbildung lässt sich die Andeutung der Zytokinese, d. h. sog. transitorische Zellplattenbildung im Anschluss an die heterotypische Karyokinese erkennen. Dies ist der Fall auch bei einigen Orchideen (z. B. *Bletilla*, *Spiranthes*, *Cypripedium*, s. YAMAHA '20 b, S. (206)) und selbst da, wo die Tetradenbildung ohne Zutun von Zellplatte, d. h. mittelst Membranleisten vollführt wird (vgl. weiter unten), was ich hier deshalb nachdrücklich hervorhebe, weil es bislang nicht selten verschiedenen Forschern entgangen zu sein scheint. Bei dem sog. Uebergangstyp fällt die auf die heterotypische Kernteilung folgende Zellplattenanlage niemals, wie bei der gewöhnlichen simultanen Tetradenbildung, einer Rückbildung anheim, sondern die einsetzende Zytokinese wird häufig mit Hautschichtbildung unterbrochen, um erst nach der zweiten Kernteilung weiter zur Vollendung zu kommen.

Um ein Beispiel für diesen Uebergangstyp der Pollentetradenbildung zu nennen, möchte ich unten einiges über die Zytokinese in den Pollenmutterzellen von *Hemerocallis fulva* beschreiben; vgl. YAMAHA ('20 b, S. (206)). Wie auch sonst häufig bemerkt oder abgebildet, wird hier der Spindelraum sowohl bei heterotypischer als homöotypischer Kernteilung mit einem Chondriommantel umwallt, der durch die gewöhnlichen d. i. sauren Fixierungsmittel (z. B. FLEMMINGS Lösung) als eine Schicht von dichten Gerinnseln fixiert wird (vgl. unten, auch s. Fig. 1, 6, 18, 19, 24, 25, 27). Vorgreifend der Zellplattenbildung in der Anaphase und früheren Telophase der heterotypischen Mitose, finden sich eine Anzahl von sog. extranuklearen Nukleolen zerstreut im Zytoplasma ein und zwar vorzugsweise an oder in der Nähe der künftigen Teilungsebene (Fig. 2, 3). Gegen das Ende der Telophase ist die junge Hautschicht schon bis in die so gut wie ganze Breite des Zelläquators fertiggestellt, ohne aber noch die Mutterzellwand zu erreichen (Fig. 4). Die neu

(1) Für weitere Beispiele s. SUESSENGUTH ('21, S. 5), Stenar ('25, S. 107 ff).

angelegte Hautschicht erscheint deutlich doppelt kontouriert, doch dazwischen lässt sich von der Membrananlage stets nichts sehen (Fig. 5, 6, 7). Dieser Zustand bleibt bis Ende der homöotypischen Kernteilung beibehalten. Davon dass das betreffende doppelt strukturierte, im Zytoplasma frei gelegte Gebilde nicht aus derselben Substanz besteht, wie der Membranstoff der Mutterzellen, der sich auch hier mit Korallinsoda und Anilinblau färbt, also ohne Zweifel Kallose nach MANGIN sein muss, sondern wirklich ganz von plasmatischer Natur ist, kann man sich erst durch Lösungsversuche mit Eau de JAVELLE überzeugen. Wie man auf Grund dessen, was wir aus den Fixierungsbildern der Hautschicht sonst schliessen, erwarten kann, zeigt sich die in Frage stehende Membranstuktur insbesondere dabei immer deutlich, wo ein reichlich Säuren oder lipoidlösende Stoffe enthaltendes Fixierungsmittel angewandt wird (vgl. YAMAHARA '25). Diesbezüglich ist solches Bild, wie Fig. 6 od. 7 wiedergibt, sehr lehrreich, in welchem das Zytoplasma der Pollenmutterzellen etwas von der Membran abgelöst ist und dementsprechend auch die vermutliche doppelt strukturierte junge Hautschicht in zwei entsprechende Teile gespalten erscheint. Alles obige spricht ohne Weiteres für die Hautschichtnatur des fraglichen Gebildes. Nach Vollendung der zweiten Mitose werden die Verbindungsfäden zwischen je zwei der Enkelkerne ausgespannt und die Zellplattenbildung tritt auch an den homöotypischen Spindeln ein. Die Tetradenbildung erweist sich aber, wie Fig. 8 u. 9 veranschaulichen, nicht streng simultan, da die Membranausscheidung bei der früher angelegten Hautschicht unverkennbar ein wenig vorangeht. Der Sachverhalt erinnert gerade an die pseudosimultane Tetradenbildung etwa von *Magnolia*, *Anona*, *Nephrodium* usw. (vgl. YAMAHARA '21-'22). Wie ich schon in der vorläufigen Mitteilung häufig bemerklich gemacht habe, ist auch hier wieder die Einbuchtung in der Mutterzellwand als eine Andeutung auf die Membranleistenbildung nicht selten anzutreffen (vgl. Fig. 8).

Nun wende ich mich der anderen Frage über die Zytokinese bei der Pollentetradenteilung zu. Es gehört zu einer längst bekannten Tatsache, dass auch in den Pollenmutterzellen bei höheren Pflanzen sich derjenige mutmasslich primitive Modus der Zytokinese wieder finden lässt, welche ohne Zutun der Zellplattenbildung, also anscheinend in keinem innigen Zusammenhange mit vorhergehender Karyokinese, ausschliesslich unter Einfaltung der Mutterzelloberfläche bewerkstelligt wird (für ältere Literatur s. FARR ('16), YAMAHARA ('20 b) usw.). Erst in neuerer Zeit bei FARRS ('16) und TAHARAS ('20) Untersuchungen hat aber unsere

Kenntnis in dieser Richtung eine bedeutende Erweiterung gefunden und seither wird eine Anzahl von neuen Beispielen von Jahr zu Jahr von verschiedenen Forschern aus allerlei Pflanzengruppen der Phanerogamen hinzugebracht. Da die von FARR ('16) früher zusammengestellte diesbezügliche Uebersichtstabelle schon etwas veraltet geworden ist und ferner einige Berichtigung erfahren muss, so stelle ich aus erneuten Literaturangaben sowie nach einigen eigenen Beobachtungen folgendes Verzeichnis auf, wo die Pflanzennamen nur auf die Gattung beschränkt werden, da hier meines Erachtens im Allgemeinen keine spezifische Ausnahme zur Geltung zu kommen scheint.

1. Gymnospermen.

Ceratozamia (JURÁNYI '82), *Tetraclinis* (*Callitris*) (SAXTON '13),
Ginkgo (MANN '24)

2. Monokotylen.

Iridaceen—*Iris*? (HOFMEISTER '67), *Sisyrinchium* (FARR '22).

Gramineen—*Zea*? (KUWADA '11).

3. Dikotylen.

a. Archichlamydeae.

Saururaceen—*Houttuynia* (SHIBATA-MIYAKE '08).

Moraceen—*Cannabis* (McPHEE '24).

Polygonaceen—*Rumex* (SINOTÔ '24), *Polygonum* (SUGIURA '25 b)

Chenopodiaceen—*Beta* (SUGIURA '25 a)

Nyctaginaceen—*Mirabilis* (YAMAHARA)

Caryophyllaceen—*Melandryum* (SCHÜRHOFF '25)

Nymphaeaceen—*Nelumbo* (FARR '22)

Ranunculaceen—*Ranunculus*× (YAMAHARA)

Magnoliaceen—*Magnolia* (TSCHISTIAKOFF '75, GUIGNARD '97,
ANDREWS '02, MANEVAL '14, FARR '18,
YAMAHARA '20 b), *Liriodendron* (ANDREWS '20,
MANEVAL '14)

Anonaceen—*Anona* (SAMUELSSON '14)

Papaveraceen—*Macleya*× (YAMAHARA)

Cruciferen—*Brassica*, *Capsella*× (YAMAHARA)

Sarraceniaceen—*Sarracenia* (NICHOLS '08)

Droseraceen—*Drosera* (ROSENBERG '03, LEVINE '16)

Saxifragaceen—*Parnassia* (PACE '12)

Hamamelidaceen—*Hamamelis* (SHOEMAKER '05)

Leguminosen—*Lathyrus* (BARANETZKY '80, GREGORY '05,
LATTER '25)

- Vicia* (FRASER '14), *Acacia* (ROSANOFF '65)
Pisum (BARANETZKY '80), *Ulex* (YAMAHA)
Melilotus (CASTETTER '25), *Trifolium* (BLEIER '25)
- Rosaceen—*Rosa* (TÄCKHOLM '22).
- Tropaeolaceen—*Tropaeolum* (SACHS '74, FARR '16, YAMAHA, SUGIURA '25 a).
- Malvaceen—*Gossypium* (CANNON '03, DENHAM '24), *Althaea*× (VON MOHL '71, YAMAHA)
- Passifloraceen—*Passiflora* (HOFMEISTER '67).
- Caricaceen—*Carica* (SUGIURA '25 b)
- Thymelaeaceen—*Daphne* (OSAWA '13 b, YAMAHA).
- Oenotheraceen—*Oenothera* (BEER '11, SINOTÔ '20, YAMAHA),
Epilobium (TSCHISTIAKOFF '75)
- Umbelliferen—(HÄKANSON '23, cit. nach BLEIER '25, S. 612.)
- b. Metachlamydeae.
- Primulaceen—*Primula* (DIGBY '12, FARR '16, SUGIURA '25 b)
- Convolvulaceen—*Convolvulus* (WIMMEL '50), *Ipomoea* (BARANETZKY '08), *Quamoclit* (YAMAHA).
- Polemoniaceen—*Cobaea* (W. K. FARR '20).
- Nolanaceen—*Nolana* (CAMPIN '25).
- Solanaceen—*Nicotiana* (FARR '16), *Solanum* (YOUNG '23),
Datura (YAMAHA).
- Scrophulariaceen—*Digitalis* (YAMAHA)
- Orobanchaceen—*Lathraea* (GATES '24)
- Caprifoliaceen—*Sambucus*× (YAMAHA)
- Valerianaceen—*Patrinia*× (YAMAHA)
- Dipsaceen—*Scabiosa* (YAMAHA)
- Cucurbitaceen—*Cucurbita* (MIRBEL '32, CASTETTER '26),
Momordica (YAMAHA).
- Campanulaceen—*Campanula*, *Adenophora* (YAMAHA)
- Compositen—*Dahlia* (ISHIKAWA '11, YAMAHA), *Crepis* (BEER '16), *Taraxacum* (OSAWA '13 a), *Chrysanthemum* (TAHARA '15, '21, FARR '16), *Helianthus* (FARR '16), *Ambrosia* (FARR '16), *Aster*, *Cirsium*, *Cosmos*, *Tagetes* (YAMAHA '20 b), *Lactuca* (GATES '20, GATES u. REES '21, SUGIURA '25 b), *Leontodon*, (MEYER '25).

Bei dem mit × bezeichneten Gattungen wurde auch Zytokinese durch Zellplattenbildung beobachtet.

Bei der Durchsicht auf die obenstehende Tabelle ergibt sich ohne Weiteres, dass sich dieser Typ der Zytokinese bei Pollentetradenbildung, wie ich „Membranleistentyp“ nennen will, zu einer gewissen systematischen Stellung der Pflanzen in enger Beziehung bringen lässt. Diese Bevorzugung der bestimmten Pflanzengruppen bezüglich des Zellteilungsmodus erweist sich so weitgehend, dass sich der letztere nicht selten auf die ganze Familie (z. B. Magnoliaceen, Leguminosen, Solanaceen, Compositen usw.) oder höchst wahrscheinlich sogar auch auf gewisse Pflanzenreihen (z. B. Ranales, Rosales, Tubiflorae) erstreckt. Bemerkenswert ist noch, dass unter Monokotylen *Sisyrinchium* (FARR '22) (*Iris* nach HOFMEISTER '67 verdächtig) ein einziges bekanntes Beispiel liefert, und weiter dass ausser vereinzelt Fällen (z. B. Magnoliaceen) dieser Modus der Tetradenbildung ausnahmslos mit der simultanen Zellteilung verknüpft ist. Von Interesse ist auch der Umstand, dass diese scheinbar primitive Art der Zytokinese mit der abnorm verlaufenden Karyokinese (z. B. bei *Taraxacum*, *Hieracium*, *Mirabilis*, *Lathyrus*, *Houttuynia*, *Zea* usw.) oder mit der künstlich ausgelösten Zellteilung (s. HABERLANDT '19) zusammenkommen kann. Man hat übrigens Grund anzunehmen, dass, wie man unten sehen wird, dieser Modus der Tetradenteilung einen der primitiven Typen der Zytokinese überhaupt vorstellt. Hier sei nur betont, dass die Zellmembran der Pollenmutterzellen (spezielle Mutterzellwand), soweit meine bisherige vereinzelte Beobachtung reicht, so gut wie immer aus Kallose besteht, und demzufolge sich die Pollenmutterzelle gerade wie eine nackte Zelle verhält, zumal da in meisten Fällen (Ausnahme: *Digitalis* usw.) die sie zunächst miteinander verbindende Mittellamelle hier spätestens bis zum Ende der zweiten Kernteilung der Pollenmutterzelle restlos aufgelöst zu sein pflegt.

Was die Kenntnis über die Einzelheiten des Zytokinesenvorgangs dieser Art betrifft, so bleibt hier noch manches zu wünschen übrig, ein Umstand, der mich dazu anregte, zu der Berichtigung und dem Nachtrag zu bisher vorliegenden Angaben (z. B. FARR '16, '18, GATES '24 usw.) die einschlägige Frage auf einige Punkte hin noch weiterer Betrachtung zu unterziehen.

Zunächst möchte ich insbesondere darauf aufmerksam machen, dass nach eigener Erfahrung bei dem Teilungsvorgang derjenigen Pollenmutterzellen, wo die Tetradenbildung lediglich mit Hilfe von Membranleisten simultan herbeigeführt wird, alles ganz und gar in derselben Weise vorgeht, wie in den Fällen, wo die Pollentetrade durch simultane Zytokinese mittelst Zellplattenanlage zur Bildung gelangen soll, solange

es sich nur auf den eigentlichen Vorgang der Scheidewandbildung nicht bezieht. Denn nicht nur der ganze Verlauf von beiden Typen der Karyokinesen, sondern auch die sämtlichen Einzelheiten über die sich an die letzteren anschliessenden zytoplasmatischen Veränderungen, so z. B. Verhalten der Verbindungsfäden, Erscheinen der extranuklearen Nukleolen, Chondriommantel um Spindelraum, Bildung der transitorischen Zellplatten auf heterotypische wie homöotypische Spindelfiguren usw. (s. YAMAHA '20 a. u. b.) wurden bei den von mir beobachteten Pollenmutterzellen beider Zytokinesentypen ebenfalls wiederkehrend gefunden. Ueber die Erscheinung der transitorischen Zellplatten auch bei der Pollenmutterzelle, wo die Zellplattenbildung zur Zytokinese in keiner Beziehung steht, liegen schon vereinzelte Angaben vor (vgl. GUIGNARD, FARR, GATES usw.).⁽¹⁾ Solche traten mir besonders häufig bei den Pflanzen aus Magnoliaceen, Leguminosen, Kompositen usw. entgegen (vgl. Fig. 20–22, 32, 38). Damit soll aber nicht ausgesagt werden, dass die Sachlage immer so sein muss. Unter Berücksichtigung der relativen Seltenheit der positiven Angaben, möchte ich nur so viel hervorheben, dass die betreffende vergängliche Bildung bislang verschiedenen Forschern nicht selten entgangen zu sein scheint, da das entsprechende Stadium in lebendem Zustand recht schnell verlaufen muss. Der alleinige Unterschied zwischen beiden Typen der Pollentetradenbildung liegt gerade darin, ob sich die Zellplatten definitiv am Zytokinesenvorgang beteiligen oder nicht. Trotzdem verschwindet auch beim Membranleistentyp der Verbindungsfadenkomplex mit Häufigkeit bei der gewöhnlichen Fixierung nicht so früh, wie die Zellplatten selbst, sondern ich fand ihn in nicht wenigen Fällen bei Einschnürung des Protoplasten gleichsam verdichtet (s. Fig. 13, 14, 30, 33–35, 39), was die früher von mir vertretene Ansicht begünstigen dürfte, dass die achromatischen Fäden aller Wahrscheinlichkeit nach keine Zellstruktur darstellen sollen, die weder zur Zytokinese noch Karyokinese in einer engen, sozusagen ursächlichen, dynamischen usw. Beziehung steht.

Kürzlich machte GATES ('24, '25) bei der Pollenmutterzelle von *Lathraea* darauf aufmerksam, dass eine zarte furchenartige Hautschichteinfaltung hier stets der Leistenbildung der Mutterzellwand vorangeht. Die Membranausscheidung soll somit auch hier von der Hautschichtbildung zeitlich bemerkbar getrennt erscheinen, was jedoch durch meine Beobachtung an den Pollenmutterzellen anderer Pflanzen niemals be-

(1) Vgl. CASTETTER ('26, S. 3, 4).

stätigt wurde. Die Zytokinese wird dabei ausnahmslos lediglich durch die Leistenbildung von der Mutterzellenwand bewerkstelligt. Meines Erachtens wurde GATES durch die bei der Fixierung eingetretene Ablösung des Zytoplasmas von Zellwand, oder aber durch ein membranöses Zytoplasmagefüge an der Teilungsebene getäuscht, das sich durch verschiedene Fixierungsmittel als eine Fixierungsartefakte am häufigsten zu erkennen gibt (vgl. Fig. 26, 27, 28, 30, 31, 34, 35, weiter FARR '16, CASTETTER '25, '26, usw.). Die schwere Eindringbarkeit der Fixierungsmittel in das Zellinnere gibt bei manchen Pollenmutterzellen insgesamt zur Zytoplasmaschrumpfung und Hervorhebung der Membranstrukturen aller Arten Anlass (für Ausführliches s. meine weitere Mitteilung über Fixierungsversuche). In vereinzelten Fällen, etwa wie bei *Digitalis*, *Althaea*, *Tricyrtis* usw., beobachtet man weiterhin solch ein Bild, das eben an die Angabe CASTETTERS erinnert, nach welcher die Teilung der Pollenmutterzelle von *Melilotus* durch die Verschmelzung der an der Teilungsebene angesammelten Vakuolen vorgeführt werden soll. Diese Fixierungsbilder entsprechen aber als solche keineswegs den im Leben vorhandenen „metakolloidalen“ Zellstrukturen, da sie im ersteren Fall als eine Art Metaform, im letzteren als eine Fixierungsform aufgefasst werden sollen (s. YAMAHA '26 b). Die Zytoplasmadifferenzierung an der Teilungsebene, wie sie erst in fixiertem Zustand zum Ausdruck kommt, müsste nur dahin gedeutet werden, dass die Äquatorialzone der sich teilenden Zelle kolloidal, z. B. dem Quellungszustande nach, anders beschaffen ist als sonstwo, was zweifelsohne die Besonderheit der Fixierungsbilder bedingen soll.

Gegenüber der Behauptung GATES' ('25), dass der mittlere Teil der Scheidewandanlage, der angeblich durch „zytoplasmatische Aktivität“ gebildet würde, von den Membranleisten der Mutterzellwand stofflich etwas verschieden sein soll, ist noch eins anzuführen. In der vorläufigen Mitteilung habe ich schon bemerklich gemacht, dass der zuerst ausgeschiedene Membranstoff oder genauer Membranmuttersubstanz, welche das Auseinanderreißen der doppelt gebauten Hautschicht bewirkt, falls sich die letztere von der Zellplattenbildung abgeleitet hat, mit der Mutterzellwand mikrochemisch nicht übereinstimmt. Es gelingt mir hingegen nie, bei der Zytokinese mittelst Membranleisten diese Muttersubstanz des Zellwandstoffes ausfindig zu machen. Die Membranbildung müsste daher hier ähnliche Weise von statten gehen, wie bei der Verdickung der Mutterzellwand.

Bevor die Fragen über die Tetradenbildung zum Schluss kommen,

möchte ich noch einiges über die Zytomixis hinzufügen, welche bei den sich zur Teilung anschickenden Pollenmutterzellen verschiedener Pflanzen sehr häufig anzutreffen ist. Es hat den Anschein, als ob sich der betreffende Vorgang namentlich bei solchen weit verbreitete, wo die Zytokinese durch Membranleisten durchgeführt wird, ein Umstand, der auf den besonderen Zustand der Mutterzellmembran hinzudeuten scheint. Wie geläufig bekannt, findet die Zytomixis in dem Synapsisstadium am häufigsten statt. In den späteren Stadien der Meiosis der Pollenmutterzellen wurde sie bislang kaum bemerkt. (vgl. TISCHLER '21-'22, S. 117, 719; SINOTÔ '20, S. (282), '21 usw.). Bei den Pollenmutterzellen einiger Pflanzen, am auffälligsten von *Campanula*, *Daphne* usw., konnte ich unter Anwendung verschiedener Fixiermittel in jedem Stadium der Reduktionsteilung diese bizarre Erscheinung beobachten (Fig. 10-12, 15-17). Im Allgemeinen scheint sie unter Umständen vorzukommen, wo die Strukturzerstörung der Zellen leicht eintritt, und kann somit als eine der zur Nekrobiosis führenden Nekroformen aufgefasst werden (s. YAMAHATA '26 b). Als Auslösungsmomente für die Zytomixis muss man neben dem mechanischen Eingriffe beim Abpflücken der Blütenknospen sowie „metabiotischer“ Wirkung der Fixiermittel auch noch die spezifische Empfindlichkeit der Pflanzenarten annehmen, da die in Frage stehende Strukturanomalie bei einer Pflanze weitaus leichter zutage gebracht wird als bei einer anderen. Entweder beschränkt sie sich nur auf die Verschmelzung des Zytoplasmas, oder auch der Karyotinanteil wird weiter angegriffen. Im letzten Fall hat sie dementsprechend Mitosenanomalien verschiedener Arten zur Folge. Wenn die Anaphase und Telophase der Karyokinese geschädigt werden, so wird zur Kernfusion, und zu der Verspätung oder sogar dem Ausbleiben der Zytokinese Anlass gegeben.

Nach vorliegenden Literaturangaben und eigenen vereinzelt Beobachtungen stehen im Pflanzenreiche zwei sich deutlich unterscheidende Typen der Zytokinese einander gegenüber. Im wesentlichen wird nämlich die Zytokinese in pflanzlichen Zellen entweder durch die Hautschichteinfaltung der Mutterzelle oder durch die Hautschichtneubildung inmitten derselben eingeleitet.⁽¹⁾ Die beiden genannten Arten der Zytokinese, deren jeder ihrerseits weiterhin Unterabteilungen zukommen sollen, können auch zusammen an den Teilungsprozessen ein und derselben Zelle beteiligt sein.

(1) Hier mache ich nur der Bequemlichkeit halber von dem Terminus „Hautschicht“ Gebrauch. Für den mikroskopischen Befund derselben s. YAMAHATA ('26 a).

I. Zytokinese durch Hautschichteinfaltung

Dieser vermutlich primitive Typ der Zytokinese findet sich nur bei frei lebenden Zellen oder bei solchen ein, welche höchstens in lockerem Gewebeverband stehen. Somit herrscht er bei den Thallophyten vor. Die Zytokinese geschieht hier ohne irgendeine sichtbare Abhängigkeit von der Karyokinese derart, dass die Hautschicht der Mutterzelle von der Peripherie der Teilungsebene aus nach zentrifugaler Richtung in das Zelllumen hineinwachsende Einfaltung erfährt, bis es zur vollständigen Aufteilung des Zellkörpers kommt. Die mehrkernigen Zellen vermehren sich des öfteren nach diesem Zellteilungsmodus. Es lassen sich weiter drei Modalitäten der Hautschichtfaltenbildung unterscheiden:

(a) Einschnürungstyp. Bei den nackten oder nur dünn behäuteten Zellen wird der Faltungsprozess der Hautschicht zu der Einschnürung der Mutterzelle vereinfacht. Die Mutterzelle zerschnürt sich dabei schlechtweg entzwei. Bei diesem einfachsten Teilungsmodus ist natürlich von der eigentlichen Scheidewandbildung keine Rede. Die beiden entstandenen Tochterzellen gehen teils ganz auseinander (bei Einzelligen), teils bleiben sie miteinander nur lose verbunden. Diesen Zytokinesentyp beobachtet man beispielsweise bei Myxomyceten (Myxomyceten), Flagellaten, Myxobakterien, Hefezellen, Pilzen (Exosporen-bildung) und weiterhin Diatomeen (*Chaetoceros* nach SCHÜTT '88), Tetrasporenmutterzellen von *Polysiphonia* (YAMANOUCHI '06), *Griffithia* (LEWIS '09) usw. Auch bei höheren Pflanzen macht sich dieser Zytokinesentyp im Anschlusse an die anderen bemerkbar (bei Pollen- und Sporenmutterzellen s. unten).

(b) Rissspalte-Typ (Cleavage-Typ). Im Gegensatze zum vorangehenden Typ erfolgt hier wirklich eine Scheidewandbildung, wenn die sich teilende Zelle auch häufig die leiseste Einschnürung ihrer Aussenkontour aufweisen mag. Die hierbei in Erscheinung tretende zentripetal fortwachsende Rissspalte („Cleavage“ in tierischen Zellen) des Protoplasten stellt nichts anderes dar als einen in Falten geschlagenen Hautschichtabschnitt der Mutterzelle. Davon kann man sich nur bei der Beobachtung des Anfangsstadiums der Scheidewandbildung leicht überzeugen. Gelegentlich tritt vor oder nahe an dem wachsenden Ende der jungen Hautschicht irgendeine Plasmadifferenzierung, z. B. Anhäufung des körnerfreien Hyaloplasmas, Mikrosomen usw. auf. Diese Zytokinesenmodalität lässt sich dadurch vom nächststehenden Typ (c) unterscheiden, dass die Membranausscheidung da von

der Protoplastenteilung mindestens für einzelne Zellen zeitlich offenbar getrennt erscheint. Hierher gehören die Zytokinesen in den Sporangien von Myxomyzeten und Eumyzeten (z. B. *Synchytrium*, *Pilobolus*, *Sporodinia*, *Rhodochytrium* usw.), bei der Zoosporenbildung von *Hydrodictyon* (KLEBS '91), wahrscheinlich auch bei Pilzmyzelien, Bakterien und Zyanophyzeen usw.⁽¹⁾

(c) Membranleistentyp. Die Zytokinese wird hier scheinbar durch das zentripetale ring- oder leistenförmige Hineinwachsen der Mutterzellwand veranlasst, welche letztere mit Häufigkeit schon vorher auffällig verdickt erscheint. An dem wachsenden Ende der Membranleisten kann man manchmal die Verdichtung der Plasmawandbelege, Mikrosomenhaufen usw. bemerken, was die entsprechende Beteiligung der Plasmataktivität am Zytokinesenvorgange schliessen lässt. Dieser Typ verbreitet sich recht weit bei Thallophyten, sowohl den einzelligen als mehrzelligen, so z. B. Bakterien (s. BENECKE '12, S. 154 ff, HINZE '01), Zyanophyceen (ACTON '14, HAUPT '23 usw.), Diatomeen (*Surirella*, nach LAUTERBORN '96), Fadenalgen (*Spirogyra*, *Cladophora*, *Chaetomorpha*, *Codium*, usw.), Pilzen (*Penicillium*, *Empusa* usw.) usw. Bei den Kormophyten liefern die typischen Beispiele, abgesehen von einigen abnormen Fällen, nur die Pollenmutterzellen von einigen Gymnospermen und zahlreichen Angiospermen (s. oben). In den kugeligen Zellen kommt mehrfach auch die Einschnürung der Mutterzelle der Membranleistenbildung in verschiedenem Masse entgegen.

II. Zytokinese durch Hautschichtneubildung

Der zweite Modus der Zytokinese zeichnet sich dadurch aus, dass die Membranbildung stets intrazellulär, d. h. gänzlich unabhängig von der Hautschicht der Mutterzelle herbeigeführt wird. Die simultane Scheidewandbildung lässt sich erst dadurch erzielen. Von den intrazellulären Zytokinesen kann man folgende drei Arten unterscheiden:

(a) Vakuolentyp. Hier bildet sich neue Hautschicht durch die Verschmelzung der an der Teilungsebene angesammelten Vakuolen. Dabei geht die Hautschichtbildung in der Regel in ganzer Breite der

(1) Es scheint mir, dass dieser Zytokinesentyp, welcher sich erfahrungsgemäss niemals da zu erkennen gibt, wo die Zellmembran freiliegender Mutterzelle mässig entwickelt ist, in der Literatur am häufigsten versehentlich mit dem nachfolgenden Typ (c) verwechselt ist. Siehe weiter OLIVE ('06), BENECKE ('12, S. 154 ff), HAUPT ('23), IKARI ('23) usw.

Teilungsebene so gut wie gleichzeitig von statten. Die simultane Hautschichtbildung dieses Typs wird z. B. bei der Zoosporangiumbildung von *Vaucheria* (nach STRASBURGER '80), Sporangiumbildung und simultanen Vielzellbildung von Phycomyceten (nach ROTHERT '72, HARPER '99 usw.) usw. gefunden. Vereinzelt wurde auch hier die zentripetale Zytokinese angegeben (s. z. B. YAMANOUCHI '06, LEWIS '09), wobei auch die Einschnürung der Mutterzelle hinzukommen kann. Da aber die Vakuolen nicht nur durch gebräuchliche Fixiermittel sehr mangelhaft konserviert werden, sondern auch bei Fixierung als Fixierungsformen (s. YAMAHA '26 b) zur Bildung kommen können, so wäre es nicht ganz einwandfrei, aus den dem fixierten Objekte allein entnommenen Befunden über die Einzelheiten der Zytokinesenvorgänge Schlüsse zu ziehen, wie es doch früher häufig getan wurde (s. auch oben). Wenn man die Ebenbürtigkeit der Vakuolenwand (Tonoplast DE VRIES' '85, S. 538) mit der Hautschicht (Plasmahaut PFEFFERS) annehmen dürfte, wofür wir den kolloidchemischen Grund nicht entbehren, so würde der in Rede stehende Modus der Zytokinese gerade mit den vorstehenden zusammengehörig.⁽¹⁾ Die Zellwandanlage wird denn hier natürlich an der Oberfläche der Vakuolenwand ausgeschieden, was ohne Schwierigkeit mit der angeblichen formativen bzw. membranbildenden Fähigkeit der Vakuolenwand in Einklang gebracht werden könnte (vgl. HARPER '00, LUNDEGÅRDH '21, S. 322, SCHWARZE '22, NIENBURG '24 usw.). Im Zusammenhange hiermit verdient die Ansicht ein theoretisches Interesse, nach welcher die achromatischen Fäden, die, sofern die Beobachtung an fixierten Objekten in Betracht kommt, im höheren Pflanzenreiche zur Hautschichtbildung stofflich in enger Beziehung zu stehen scheinen, als eine Art Vakuolensystem angesehen werden sollen (s. YAMAHA '26 a, auch unten). Übrigens sei noch der Beachtung wert, dass zur Zeit noch kein einziges zuverlässiges Beispiel vorliegt, wo sich die Zytokinese nach Vakuolentyp im unmittelbaren Anschlusse an die Karyokinese vorfindet.

(b) Mikrosomentyp. Abgesehen von der Zytokinese kommt die Hautschicht oder die gleichwertige Membranstruktur des Protoplasmas bekanntlich auch aus der Zusammenschmelzung der mikroskopisch dispersen Phasen desselben (Mikrosomen) hervor (s. YAMAHA '26 a, weiter STRASBURGER '84, S. 109, KLEBS '86-88, S. 511, TISCHLER '01, S. 248, LOEB '09, S. 270, LUNDEGÅRDH '21, S. 240 ff). Es befremdet

(1) Für die ausführliche theoretische Betrachtung über die Membranstrukturen überhaupt s. YAMAHA ('26 a, b).

also nicht, dass in Wirklichkeit ein solcher Typ der Zytokinese existiert, wo die Hautschicht dem Mikrosomenhaufen ihren Ursprung verdankt. Die schönen Beispiele sind in Menge bei verschiedenen Algenzellen zu sehen, so z. B. *Sphacelaria* (STRASBURGER '80, '92; SWINGLE '97), *Dictyota* (MOTTIER '00), *Cutleria* (YAMANOUCHI '09, '12), *Fucus*-Oogonien (FARMER und WILLIAMS '96, STRASBURGER '97) usw. Als auffallend ist noch zu bemerken, dass dieser Zytokinesentyp nur bei einkernigen Zellen auftritt, und weiter dass der Verlauf der Scheidewandbildung im Allgemeinen sukzedan, d. h. sowohl zentrifugal (etwa bei *Stypocaulon*) als auch zentripetal (wie bei *Dictyota*) ausfällt, wenn es auch an Fällen nicht fehlt, wo die simultane Hautschichtbildung angegeben ist, wie bei *Oedogonium* nach STRASBURGER ('80). Da die Mikrosomen, wie ich früher anderswo hervorgehoben habe, einer der schwer fixierbaren Strukturen angehören, so muss man sich hierbei an lebendem Material allein halten, um die genaue Kenntnis davon zu erzielen (vgl. YAMAHA '26 a). Im fixierten Zustand erscheint der Sachverhalt häufig dergestalt, dass die neue Hautschicht gleichsam aus der Verschmelzung und Umwandlung der Alveolarwände an der Teilungsebene hervorgeht (s. z. B. MOTTIER a. a. O.). Dazu kommt noch eine technische Schwierigkeit, nämlich dass sich die zarten Vakuolen von den Mikrosomen mikroskopisch kaum unterscheiden lassen (s. GUILLIERMOND '21, LUNDEGÅRDH '21, S. 252, 321, 322, 324). Daraus entstehen eine Menge von verdächtigen Fällen, in denen man zwischen dem Mikrosomentyp und dem Vakuolentyp nur mit Schwierigkeit unterscheiden kann.

Soweit meine Beobachtung reicht, beschränkt sich dieser Modus der Zytokinese nur auf die Thallophyten und zwar bei einkernigen Formen. Es scheint mir höchst wahrscheinlich zu sein, dass das Ineinandergreifen der Karyokinese und Zytokinese erst in dieser Entwicklungsstufe der Zytokinesentypen zum Vorschein gekommen ist.

Was die Membranausscheidungsprozesse angeht, so geht hier alles in übereinstimmender Weise vor sich, wie bei dem nachstehenden Typ der Zytokinese (s. unten).

(c) Zellplattentyp. Bei den in Gewebeverband stehenden Zellen aus Charophyten und Kormophyten schliesst sich die Zytokinese insofern unmittelbar an die Karyokinese an, als die junge Hautschicht inmitten der Spindelsubstanz angelegt wird, welche erst als eine der metabiotischen⁽¹⁾ Formen die fädige Struktur aufweist (s. YAMAHA '26 b). Da die

(1) Wahrscheinlich eine Art Entquellungsform.

körnigen Elemente der Zellplatte bzw. die sog. Dermatosomen nach meinen Beobachtungen ausschliesslich aus der äquatorialen Verdickung der „Verbindungsfäden“ hervorgehen, und weiter die letzteren nur in fixiertem Zustand sichtbar sind, so darf man wohl dann die klassische Bezeichnung „Zellplatte“ entbehren, wenn die Spindelsubstanz (Phragmoplast) nicht fädig strukturiert erscheint, wie man in lebenden Zellen und bei der Anwendung gewisser Fixiermittel sehen kann (s. YAMAHA '25). Kurzum richten sich die Fixierungsbilder der Zellplattenelemente lediglich nach denen der Spindelsubstanz, wie die Fig. 36, 37, 40, 42, 44–47 veranschaulichen. Nach eigenen daraufhin angestellten Beobachtungen an lebenden Objekten scheint die Hautschichtanlage gerade in der Mitte der Äquatorialebene des Phragmoplasten ohne irgendeinen Vorboten plötzlich aufzutreten, während in fixiertem Zustand die Zellplattenbildung anscheinend der Hautschichtanlage voranzugehen pflegt. (YAMAHA '26 a). Das fragliche Fixierungsbild lässt sich also dahin deuten, dass es diejenige weder mikroskopisch noch ultramikroskopisch auflösbare vorübergehende kolloidale Zustandsänderung widerspiegelt, welche, der Hautschichtbildung vorgreifend, innerhalb der Zelle in Gang kommen muss. Dementsprechend erscheint der Phragmoplast eben im betreffenden Stadium im Leben merklich stärker lichtbrechend als früher, und im fixierten Zustand am häufigsten mit extranuklearen Nukleolen besät (s. YAMAHA '20 a u. b; '26 a u. b). Bei der Anwendung der gebräuchlichen Fixiermittel (vgl. YAMAHA '25) unterscheidet sich im Phragmoplasten neben Verbindungsfadenkomplex noch eine gewisse Menge von homogenem Gerinnsel, welches sich aber gerade nur der Äquatorialzone des Phragmoplasten entzieht, wo eine schöne Reihe der Dermatosomen zu Gesicht kommt (Fig. 36, 40 usw., vgl. YAMAHA '20 a u. b). Es macht nun den Eindruck, als ob sich die Spindelsubstanz in dieser Zone beim Fixierungsprozesse zur Fällung der Dermatosomen verzehrt hätte. Es handelt sich ja eben um dasjenige Stadium, das der Hautschichtbildung unmittelbar vorausgeht, wobei der kolloidale Zustand des Zytoplasmas dort allenfalls leicht zur absteigenden Veränderung geneigt ist.

Die Spindelsubstanz geht der Regel nach gleich mit dem Auftreten der neuen Hautschicht oder Scheidewandanlage in Schwund, um durch das „Körnerplasma“, d. h. die gewöhnliche mit Mikrosomen versehene Struktur des Zytoplasmas ersetzt zu werden, ein Umstand, der zumal bei der sogenannten sukzedanen Scheidewandbildung auffallend hervortritt, wo sie sich nur auf den schmalen wachsenden Rand der Hautschicht

(„Wuchszone“ des Phragmoplasten; s. YAMAHA '20 a u. b) beschränkt.⁽¹⁾

Die eben erst angeführte Mikrosomensammlung an beiden Seiten der jungen Hautschicht scheint bisher gelegentlich der Lebendbeobachtung häufig fälschlich als eine Zellplattenanlage gedeutet zu sein, da die im Leben gerade auf der Grenze der Sichtbarkeit schwebende Hautschichtanlage dabei leicht zu übersehen ist.

Wir können fernerhin immer dann schon in der früheren Telophase von der Spindelsubstanz nichts mehr wahrnehmen, wenn die Zytokinese entweder normalerweise, wie bei manchen Pollenmutterzellen (s. oben), oder auch unter künstlich hergestellten Aussenbedingungen (vgl. YAMAHA '26 b) gänzlich unterbleibt.

Alles obige spricht allerdings recht überzeugend für die nicht unbedeutende Rolle, welche die Spindelsubstanz vermutlich beim Zytokinesenvorgang spielt. Dabei darf man aber nicht mit den verschiedenen Fixierungsbildern der Spindelsubstanz, nämlich etwa der faserigen Struktur derselben getäuscht werden, weil der normale Verlauf der Zytokinese nach Zellplattentyp, wie man bei meinen experimentell-zytologischen Untersuchungen wiederholt gesehen hat, anscheinend unabhängig von den Fixierungsbildern des Phragmoplasten vor sich gehen kann.

Es verdient noch eine besondere Beachtung, dass die frisch angelegte Hautschicht in lebendem Zustand solange niemals doppelkontouriert erscheint, also äusserst schwer nachweisbar bleibt, bis der Membranstoff schon da ausgeschieden worden ist. Dagegen findet man sie beim fixierten Objekte manchmal deutlich doppelt strukturiert, ohne jedoch die Membrananlage dazwischen zu bemerken.⁽²⁾ Die angebliche Doppelatur, die der Hautschichtanlage vom ersten Anfange ihrer Entstehung zukommen soll, wurde weiter auch durch die von mir daraufhin angestellten Plasmolyse- und Fixierungsversuche bestätigt, indem die beiden auseinandergewichenen Hälften der jungen Hautschicht als eine der Entquellungsformen in die Augen fallen (vgl. YAMAHA '26 a u. b). Dieser Befund dürfte zugleich weiterhin einen zwingenden Beweis dafür beibringen, dass die Membranausscheidung auch hier unbedenklich zeitlich von dem Prozesse der Hautschichtbildung merkbar getrennt erscheint, obschon die beiden Erscheinungen in diesem Fall in der Teilungsebene immer nach der gleichen, d. h. für gewöhnlich zentrifugalen

(1) Ebenderselbe Zustand lässt sich auch auf dem experimentellen Wege bei den meristematischen Zellen aus Wurzelspitzen einiger Pflanzen herstellen (vgl. YAMAHA '26 b).

(2) S. z. B. Fig. 5-7, 45, 47.

Richtung hin von stattem gehen.⁽¹⁾

Beim Zellplattentyp schreitet jede von drei nacheinanderfolgenden Stufen der Zytokinese, Zellplatten-, Hautschicht- und Membranbildung, insofern in der Regel zentrifugal fort, als es sich um eine normale Zelle handelt. Weder bei den plasmareichen Zellen noch bei den verlängerten, eine schmale Teilungsebene besitzenden, wird die Scheidewandbildung durch die ganze Breite des Phragmoplasten hindurch in der Strenge simultan vollzogen. Allgemeine Geltung kommt daher dem Satze MÜLLERS ('12) zu, dass jede Zellteilung überall sukzedan erfolgt. Nur bei den Pollenmutterzellen einiger Liliaceen, so z. B. von *Tricyrtis*, *Hemerocallis*, *Lilium*, *Yucca* usw. fand ich sozusagen quasisimultane Scheidewandbildung. Da geht nämlich die Zytokinese im ungleich grösseren Teil der Teilungsebene nach Zellplattentyp so gut wie gleichzeitig vor sich, während die schmale, sich an die Mutterzellwand ansetzende Peripherie der Scheidewand durch die Leistenbildung dem schon angelegten Hauptteil derselben nachgetragen wird (vgl. YAMAHA '20 b).

Die Bezeichnung Zellplatte (STRASBURGER '80) soll hier nur auf diejenige Zytoplasmastruktur Anwendung finden, welche mit der Spindelsubstanz im genetischen Zusammenhange zu stehen scheint. Manche Autoren wollen dennoch auch bei Thallophyten von Zellplatte sprechen, wobei von der Beziehung fraglicher Gebilde zur Spindelsubstanz trotzdem nichts zu verspüren ist (vgl. z. B. STRASBURGER '08, MERRIMAN '06, IKARI '23; weiter TISCHLER '21-'22, S. 189). Unter Berücksichtigung des Zytokinesenvorgangs, der bei den anderen Arten von Protococcales (*Chlamydomonas*, *Haematococcus*, *Volvox*, *Eudorina* usw.) verschiedenen Forschern und auch mir selbst auffällt, müsste die von McALLISTER ('13) angegebene und abgebildete Zellplattenbildung bei *Tetraspora*, die das einzige mir bekannte Beispiel aus Thallophyten ausmacht, in Frage gestellt werden. Nach seinen Abbildungen beurteilt, bleibt im übrigen, wie es mir scheint, schon die angebliche zentripetale Scheidewandbildung etwas verdächtig.

Nach alledem liegt es am nächsten, dass die Zytokinese mit Hilfe der Zellplattenbildung, welche allem Anschein nach im Laufe der Ausgestaltung des Gewebeverbandes, in Verbindung mit der Einkernigkeit der Metaphytenzelle allmählich zur Entwicklung kommt, als die den Kormophyten und Charophyten eigentümliche hinzustellen ist.

Zum Schlusse möchte ich zugestehen, dass die oben auseinanderge-

(1) Für die Ausnahmefälle s. YAMAHA ('20 b u. '26 b).

setzte Einteilung der Zytokinesentypen nur provisorisch aufgestellt wurde, um sich in der Folge durch weitere Untersuchungen noch der Ergänzung oder Veränderung unterziehen zu lassen. In der Tat kommen nicht nur eine Reihe von Übergangstypen verschiedener Abstufungen den obigen sechs Haupttypen hinzu, sondern auch die sozusagen zusammengesetzten Typen treten mit jeder möglichen Kombination überaus häufig hervor. Um einige Beispiele zu nennen, so beobachtet man bei den Tetrasporenmutterzellen von Rhodophyceen den kombinierten Zytokinesentyp von I (a) mit II (a) oder II (b); bei den Sporenmutterzellen von Bryophyten gewöhnlich I (a) mit II (c); bei den Pollenmutterzellen von Phanerogamen nicht selten II (c) mit I (a) oder I (c) usw. usw.

Alle Untersuchungen, welche der vorliegenden Abhandlung Tatsachenmaterialien geliefert haben, wurden zwischen dem Jahre 1919–1924 in hiesigem Institut unter Leitung von Herrn Prof. Dr. K. FUJII angestellt, dem ich an dieser Stelle für seine stetige Unterstützung meinen verbindlichsten Dank ausspreche.

Zusammenfassung

1. Zwei Modi der Sporentetradenteilung, d. h. simultane und sukzedane Tetradenbildung, verteilen sich innerhalb ein und derselben Pflanzengruppe in einem gewissen Zusammenhang mit der systematischen Stellung der Pflanzen, und zwar oft dergleichen, dass die erstere als der primitive und die zweite als der abgeleitete Typ aufzufassen ist.

2. Die beiden genannten Tetradenteilungsmodi verbinden sich durch eine Reihe von Übergangstypen, deren ein schönes Beispiel die Pollenmutterzellen von *Hemerocallis fulva* liefern.

3. Zytokinese nach Membranleistentyp (furrowing) wird von neuem bei den Pollenmutterzellen folgender Pflanzengattungen beobachtet: *Mirabilis*, *Madleya*, *Brassica*, *Capsella*, *Ulex*, *Althaea*, *Daphne*, *Quamoclit*, *Datura*, *Digitalis*, *Sambucus*, *Patrinia*, *Scabiosa*, *Momordica*, *Campanula*, *Adenophora* usw.

4. Dieser Modus der Zytokinese kennzeichnet die Pollenmutterzellen bestimmter Gattungen oder Familien, aber höchst wahrscheinlich auch einiger Reihen von dikotylen Pflanzen.

5. Die Einzelheiten der Zytokinesenvorgänge im Allgemeinen werden für jeden von den sechs folgendermassen aufgestellten Haupttypen erörtert:

- (1) Zytokinese durch Hautschichteinfaltung;
 - (a) Einschnürungstyp.
 - (b) Risspalte-Typ (Cleavage-Typ).
 - (c) Membranleistentyp.
- (2) Zytokinese durch Hautschichtneubildung;
 - (a) Vakuolentyp.
 - (b) Mikrosomentyp.
 - (c) Zellplattentyp.

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Figurenerklärung der Tafel IV—VI

Alle Mikrophotographien wurden mit Hilfe der BECKSchen mikrophotographischen Kamera unter Anwendung vom ZEISS' apochromatischen Objektiv 2 mm (N. A. 1,3) und Kompensationsokular 8 ($\times 10$) aufgenommen; Vergrößerung ungefähr $\times 1000$. Färbung der Präparate geschah mit HEIDENHAIN'S Eisenalaunhämatoxylin und Lichtgrün oder mit Alizarinbordeaux-Aluminiumsulfat. Schnittdicke 5 mikra.

TAFEL IV

Fig. 1-9; Pollenmutterzellen von *Heimerocallis fulva*. Fixiert mit FLEMMINGScher Flüssigkeit.

1. Heterotypische Metaphase mit zerstörtem „Chondriommantel“.
- 2, 3. Heterotypische Anaphase; die der Zellplattenbildung vorangehenden Stadien. Extranukleare Nukleolen.
4. Heterotypische Telophase mit Zellplattenanlage.
- 5, 6. Homöotypische Prophase und Metaphase; doppelstrukturierte Hautschichtanlage und Chondriommantel.
7. Homöotypische Anaphase; Protoplast von Zellmembran abgelöst, beide Hälften der jungen Hautschicht voneinander abgerissen, ohne aber dazwischen eine Membrananlage aufzuweisen.
- 8, 9. Homöotypische Telophase; „pseudo-simultane“ Tetradenbildung.

Fig. 10-17; Pollenmutterzellen von *Campanula Trachelium* fixiert mit ZENKERS Gemische;

- 10-12. „Zytomixis“ in verschiedenen Mitosenstadien.
- 13, 14a, b. Zytokinese durch Membranleistenbildung; zurückbleibende Verbindungs-fäden.
- 15-17. Der Zytomixis nachfolgende Teilungsanomalien;
15. Zweikernige Zelle.

TAFEL V

16. verspätete Zytokinese. 17. Kernfusion.

Fig. 18-31: Pollenmutterzellen von *Daphne odora*, fixiert mit ZENKERS (18; ohne Essig-säurezusatz; 26, 31), CHAMPYS (19, 22, 24), BENSLEYS (Sublimat-Osmiumsäure; 20, 23, 27, 29. Bichromat-Sublimat-Formol; 28), JUELS Gemische (21, 30) oder Formalin (25).

- 18, 19. Heterotypische Metaphase mit „Chondriommantel“.
- 20-22. Transitorische (20) oder abnorme (? 21, 22) Zellplattenbildung nach heteroty-pischen Mitosen.
23. Heterotypische Telophase; Andeutung an die Protoplasteneinschnürung.
24. Homöotypische Metaphase. „Chondriomschranke“.
25. Heterotypische Metaphase mit „Chondriommantel“; heterotypische Telophase mit „Chondriomschranke“.
- 26-28. Andeutung auf die Membranleistenbildung; Zytoplasmadifferenzierung an der Äquatorialebene.
29. Homöotypische Anaphase; zurückbleibende Verbindungs-fäden.

TAFEL VI

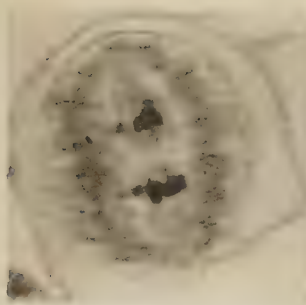
- 30, 31. Homöotypische Telophase. Tetradenbildung nach Membranleistentyp.

Fig. 32, 33; Pollenmutterzellen von *Magnolia Kobus*, fixiert mit FLEMMINGS Gemische.

32. Heterotypische Anaphase; transitorische Zellplatte.
33. Homöotypische Telophase; Membranleistenbildung; zurückbleibende Verbin-

dungsfäden.

- Fig. 34, 35. Pollenmutterzellen von *Digitalis purpurea*, fixiert mit ZENKERS Flüssigkeit. Homöotypische Telophase; Zytokinese nach Membranleistentyp; zurückbleibende Verbindungsfäden.
- Fig. 36, 37. Pollenmutterzellen von *Allium odorum*, fixiert mit FLEMMINGS Gemische. Zytokinese nach Zellplattentyp.
- Fig. 38. Pollenmutterzelle von *Ulex europaeus*. Heterotypische Anaphase mit transitorischer Zellplatte.
- Fig. 39. Pollenmutterzellen von *Aster indicus*, fixiert mit BOUINSchem Gemische. Zytokinese mittelst Membranleisten; Überbleibsel der Verbindungsfäden.
- Fig. 40-47. Verschiedene Fixierungsbilder der Verbindungsfäden und Zellplattenanlagen.
- 40-45. Wurzelspitzenzellen von *Vicia Faba*, fixiert mit TELLYESNICZKYS Gemische (40), 10 Proz. Formol (41, 42), REGAUDS Gemische (43), BENDAS Gemische (44) oder 2 Proz. Osmiumsäure (45).
46. Dieselben von *Pisum sativum*, fixiert mit MERKELS Flüssigkeit.
47. Dieselben von *Glycine Soja*, fixiert mit neutralisiertem Formol.
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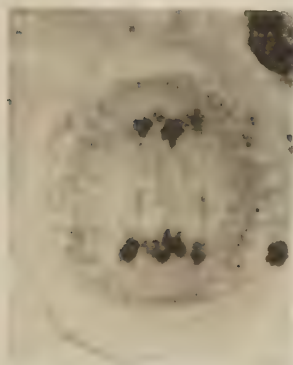
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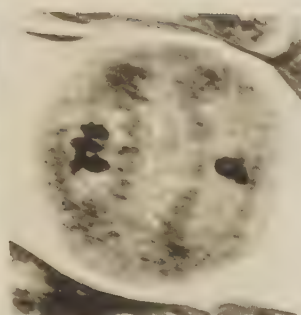
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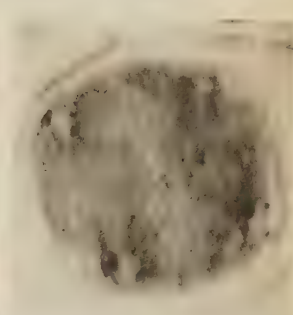
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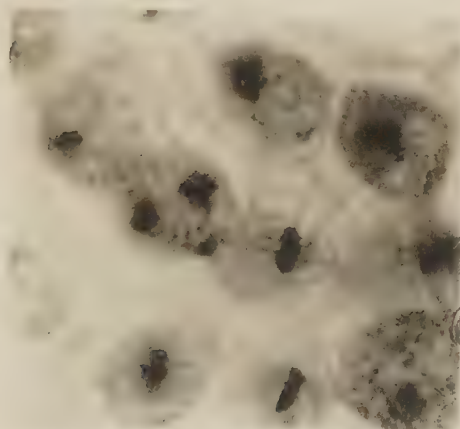
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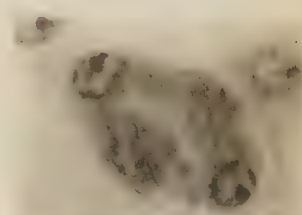
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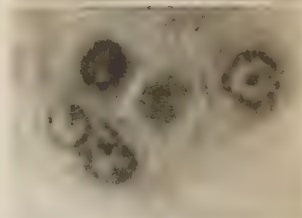
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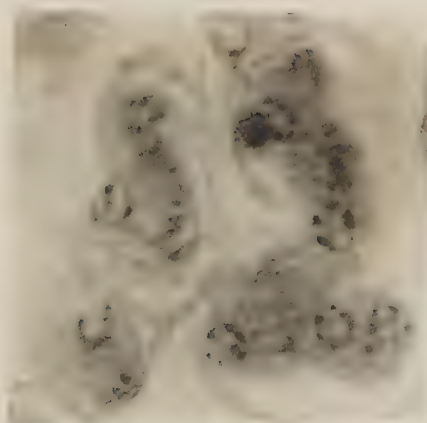
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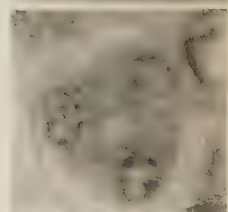
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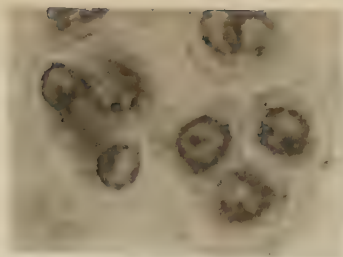
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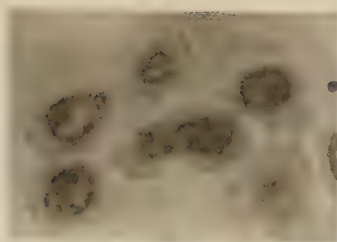
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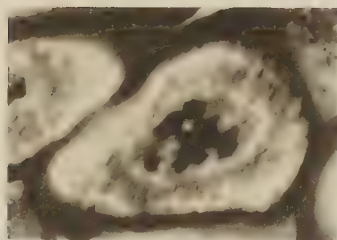
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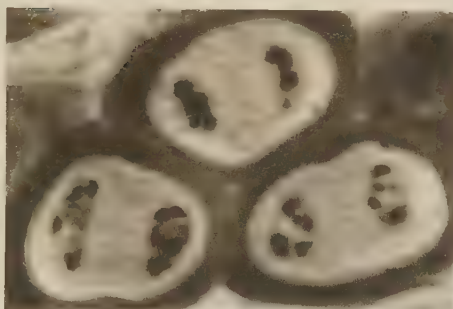
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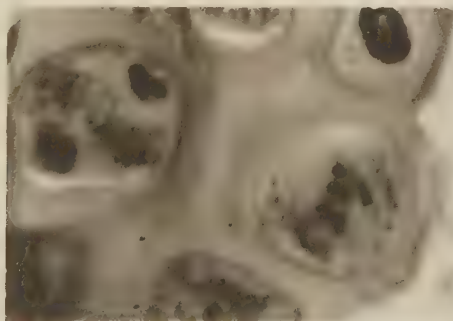
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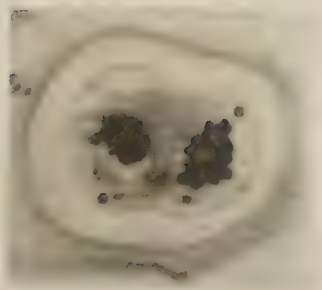
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29

On the Mutual Effects between the Plant Growth and the Change of Reaction of the Nutrient Solution with Ammonium Salts as the Source of Nitrogen

By Tsung-Lê LOO (羅宗洛) (from Chiekiang, China)

With 5 Text-figures

(Contribution from the Botanical Institute, Hokkaido Imperial
University, Sapporo. Received June 26, 1926)

It is a well-known fact that the reaction of the solutions of neutral salts in contact with the root system of the culture plants often becomes acidic or alkaline. The excretion of acid (CZAPEK, '21), alkali or other substances (NATHANSOHN, 1904) by roots might be the cause of this phenomenon. But STOKLASA ('24) and his co-workers confirmed that under normal conditions the roots give out nothing but carbon dioxide. Indeed, in most cases, the acidity or alkalinity of culture media caused by the root system seems too great to be ascribed to the excretion, and so the phenomenon is now generally accounted for by the unbalanced absorption of anions and cations. Authors like HOAGLAND ('19), DUGGAR ('20), SALTER and McILVAINE ('20) and SIERAKOWSKI ('24) did not consider the selective absorption though they recognized the reaction change. But the researches of NIKITINSKY ('04), RITTER ('11) and SAKAMURA ('24) in culture of fungi, and those of NATHANSOHN ('04), PANTANELLI ('15), DAVISON and WHERRY ('24), WOLKOFF ('18), PRIANISCHNIKOW ('08, '24, '25.) and JONES and SHIVE ('21 and '22) in culture of higher plants all prove the correctness of this theory.

Such change of reaction, which exerts important effect on plant growth, has hitherto been rather neglected as compared with the problems on the nutrient constitutions. Without careful consideration on this subject, however, the results of investigations on salts requirement as well as the effect of hydrogen ion concentration upon plant growth may be sometimes meaningless.

At the suggestion of Prof. SAKAMURA, the writer undertook the researches on the reaction change of culture media and its influence on plant growth in the early stage of development, when ammonium salts

of inorganic acids were used as the source of nitrogen. The results of experiments carried out from July 1924 to December 1925 is reported in this paper.

Methods in General

The experiments were carried out in water culture. As culture medium a modified KNOP solution was used throughout the work. The extensive contributions of TOTTINGHAM ('14), SHIVE ('15) and others on the mineral constitution of nutrient solution might enable us to select a more balanced solution for each kind of seedlings. The writer, however, has not concerned himself with the study on the relative proportion of different salts involved in the solution, and so the culture solutions used in the present study were quite satisfactory. The stock solution was prepared in two parts with their chemical compositions as follows:

Part A.

Magnesium sulphate	MgSO ₄ 7H ₂ O	5 gm
Potassium biphosphate	KH ₂ PO ₄	" "
Calcium chloride (crystal)	CaCl ₂ 6H ₂ O	0.97 gm
Distilled water		1000.cc.

Part B.

a) Ammonium nitrate	NH ₄ NO ₃	19.6 gm
b) " chloride	NH ₄ Cl	13.2 "
c) " sulphate	(NH ₄) ₂ SO ₄	16.2 "
d) " biphosphate	NH ₄ H ₂ PO ₄	28.0 "
e) " phosphate	(NH ₄) ₂ HPO ₄	16.2 "
f) ⁽¹⁾ " bicarbonate	NH ₄ HCO ₃	28.2 "
g) Sodium nitrate	NaNO ₃	20.8 "

Each of the above salts was dissolved in one litre of distilled water.

The amount of nitrogen in ammonium salts and in sodium nitrate was equivalent to that in the KNOP solution, neglecting the nitrogen in nitrate radical in the case of ammonium nitrate. In order to prevent precipitation, which is due to either the formation of calcium sulphate or calcium phosphate, the amount of calcium has been much lessened. As the function of calcium ions consists chiefly in maintaining the physiological balance of the nutrient solution, in many cases even a

(1) The ammonium bicarbonate was prepared by bubbling CO₂ through the solution of ammonium carbonate.

small quantity will be sufficient. The stock solution, thus prepared, without any trace of iron, remained free from precipitation for almost fourteen days under the temperature of from 15° to 26°C. An addition of few drops of ferric chloride, however, caused a heavy precipitation, and rendered it almost unfit for the experiment. Accordingly the addition of iron was avoided till each equal volume of the two parts of the stock solution was mixed and the final dilution was completed. Then one drop of a two per cent solution of iron salts, either in the form of ferric or ferrous sulphate, was added to each 500 cc. of culture solution. MERCK's chemicals were exclusively used. The osmotic pressure of each solution has not been determined, but it does not seem that any great variation exists among these solutions.

The distilled water used in the present work was prepared by treating it with MERCK's animal black or with KAHLBAUM's blood coal. That distilled water thus treated was free from copper and other oligodynamically toxic substances is evident from the fact that *Spirogyra* could grow in it quite well for one day or so, while the untreated distilled water proved decidedly poisonous to that alga (SAKAMURA, '22.). The pH-value of the treated water was 7.4 when CO₂ is thoroughly driven out of it. This slight alkalinity does not have any marked effect, since the culture media are so-called synthetic solutions which possess buffer action⁽¹⁾ to some extent.

The vessels used in this work were made of non-alkaline glass, and some of them were of Jena glass, in some other cases porcelain cylinders were used for the same purpose. They were washed with chrom-sulphuric acid and then thoroughly rinsed with tap and distilled water. All vessels were covered with black paper or placed in boxes to exclude the sunlight.

The initial pH-value of the nutrient solutions was determined whenever they were prepared. The colorimetric method of CLARK and LUBS ('23) was employed in the determination of hydrogen ion concentration, using both their standards and indicators.

The seeds of wheat and paddy rice were germinated in a germination dish. Before germination, the seeds were treated with the dilute solution of hydrogen peroxide, sometimes with Uspulun or Zonite. The germination of the seeds of all other plants used in this work was carried out in the wet saw dust. They were transferred to the culture

(1) In this work, by buffer action we mean the power of resistance exhibited by a solution to the increase of H-ion concentration.

solutions when the seedlings attained the length of about 3-9 cm. At the end of the experiments, the seedlings were dried at 100°C in the dry oven.

The dry weight of the shoots and roots, the length of the shoots, the general appearance, and in some of the experiments, the green weight were measured as the criterion of growth. Stress was laid on the dry weight in the case of the longer-intervalled culture, while the observation of general appearance, such as root development, was preferred, if the culture duration was comparatively short.

All the experiments were carried out in triplicate and the average value was calculated from the experimental results.

I. Change of Reaction of Nutrient Solutions due to the Unbalanced Absorption of Ions by Seedlings

Experiments with seedlings of *Zea Mays*, *Fagopyrum esculentum* and *Oryza sativa* were conducted in order to trace out first the daily change of pH-values of the nutrient solutions produced by the culture plants. In the case of *Zea Mays* and *Oryza sativa* the residual endosperms were picked off. Every experiment lasted eight days, during which period neither addition nor renewal of solutions was made. Five cc. of the culture solution were taken with pipette every day for determination of the hydrogen ion concentration. These cultures were carried under sufficient sunlight condition.

EXP. 1. *Zea Mays*.

Three seedlings were grown in each cylindrical jar of 13 cm. high, 7.5 cm. inner diameter, having a capacity of 400 cc. The nutrient solutions used in this experiment were as follows:

N-sources in the solution	Stock solution		Sum (cc.)	pH
	A (cc.)	B (N-source) (cc.)		
NaNO ₃	10	10	400	5.2
NH ₄ NO ₃	"	"	"	5.1
NH ₄ Cl	"	"	"	"
(NH ₄) ₂ SO ₄	"	"	"	"
(NH ₄) ₂ HPO ₄	"	"	"	6.8
NH ₄ HCO ₃	"	"	"	7.6

The results obtained from this experiment are summarized in Table I and illustrated in Fig. 1 (p. 169).

TABLE I

Zea Mays: 3 seedlings in each culture containing 400 cc. of nutrient solution. Culture duration: July 7-14, 1924. Temp. 24-32°C

Kinds of N-sources in the solution.	pH								Growth		
	initial	daily changes							Length of shoot (cm)	Green weight (gm)	Dry weight (gm)
		1	2	3	4	5	6	6.8			
NaNO ₃	5.2	5.6	6.0	6.1	6.1	6.3	6.6	6.8	24.3	3.640	0.615
NH ₄ NO ₃	5.1	5.2	5.6	5.7	5.9	5.9	5.9	5.9	22.7	3.683	0.477
NH ₄ Cl	5.1	4.4	4.4	4.3	4.3	4.0	3.8	3.7	20.3	3.431	0.282
(NH ₄) ₂ SO ₄	5.1	4.7	4.6	4.4	4.4	4.2	4.0	3.9	19.3	3.419	0.254
(NH ₄) ₂ HPO ₄	6.8	6.7	6.7	6.7	6.7	6.5	6.5	6.4	23.0	3.686	0.661
NH ₄ HCO ₃	7.6	7.6	7.5	7.4	7.5	7.4	7.4	7.4	22.3	3.812	0.637

EXP. 2. *Oryza sativa*, "Akage."

The seeds of paddy rice plants used in this experiment were originated from a pure line of the variety "Akage", which was secured through the kindness of Hokkaido Agricultural Experiment Station. Instead of cylindrical jar ERLLENMEYER flasks were used as culture vessels. Five plants of uniform size were chosen for each culture. Each culture contained 270 cc. of nutrient solutions of the following compositions:

N-sources in the solution	Stock solution		Sum (cc.)	pH
	A (cc.)	B (N-source) (cc.)		
NaNO ₃	50	50	3000	5.2
NH ₄ NO ₃	"	"	"	5.1
NH ₄ Cl	"	"	"	"
(NH ₄) ₂ SO ₄	"	"	"	"
(NH ₄) ₂ HPO ₄	"	"	"	6.8
NH ₄ HCO ₃	"	"	"	7.6

The results of this experiment are shown in the Table II and Fig. 2 (p. 169).

TABLE II

Oryza sativa: 5 seedlings in each culture containing 270 cc. of nutrient solution. Culture duration: August 4-11, 1924. Temp. 28-30°C

Kinds of N-sources in the solution	pH								Growth		
	initial	daily changes							Length of shoot (cm)	Green weight (gm)	Dry weight (gm)
		1	2	3	4	5	6	7			
NaNO ₃	5.2	5.5	5.6	5.5	5.6	5.7	5.7	5.7	13.9	0.322	0.041
NH ₄ NO ₃	5.1	5.0	4.8	4.7	4.5	4.4	4.5	4.4	14.6	0.324	0.0423
NH ₄ Cl	5.1	5.0	4.8	4.4	4.3	4.3	4.2	4.1	14.2	0.309	0.0410
(NH ₄) ₂ SO ₄	5.1	5.0	4.8	4.4	4.2	4.2	4.3	4.2	14.3	0.325	0.0430
(NH ₄) ₂ HPO ₄	6.9	6.8	6.8	6.7	6.7	6.7	6.7	6.7	12.4	0.290	0.040
NH ₄ HCO ₃	7.6	7.7	8.0	8.0	8.0	8.1	8.2	8.3	10.7	0.290	0.035

EXP. 3. *Eagopyrum esculentum*, "California."

Method of experimentation was exactly the same as in the foregoing experiment. At the beginning of the experiment, the plants showed an abnormal appearance and practically made no growth at all, but on the sixth day they recovered. Consequently the duration of the experiment had to be prolonged.

The change of reaction of the solutions and the measurements of growth are summarized in Table III.

TABLE III

Eagopyrum esculentum: 3 plants in each culture containing 400 cc. of nutrient solution. Culture duration: August 14-28, 1924. Temp. 21°-27°C

Kinds of N-sources in the solution	pH								Growth		
	initial	daily changes							Length of shoot (cm)	Green weight (gm)	Dry weight (gm)
		1	2	3	4	5	6	7			
NaNO ₃	5.2	5.3	5.2	5.3	5.3	5.4	5.4	5.2	21.0	1.462	0.096
NH ₄ NO ₃	5.1	5.1	5.2	5.3	5.3	5.0	4.6	4.4	21.7	1.383	0.093
NH ₄ Cl	5.1	5.1	5.1	5.1	4.9	4.4	4.1	3.9	19	1.111	0.084
(NH ₄) ₂ SO ₄	5.1	5.1	5.2	5.1	5.0	4.4	4.1	3.8	19.1	1.156	0.079
(NH ₄) ₂ HPO ₄	6.8	6.8	6.8	6.8	6.8	6.7	6.7	6.6	19	1.068	0.085
NH ₄ HCO ₃	7.6	8.2	8.2	8.2	8.3	8.4	8.3	8.3	14.7	0.834	0.062

It will be seen that the experimental data resemble those of paddy rice in every detail. The only difference is that the hydrogen ion con-

centration of the solution containing NaNO_3 changed very little. We will come to this point later. For the present it must be pointed out that the cause of this phenomenon can not be ascribed to the poor absorption power of the seedlings, since the growth of the seedlings in this solution was comparatively good. On the other hand, the abnormal growth of the seedlings caused the decrease of H-ion concentration up to the fifth day in all solutions (Fig. 3). That the unhealthy plants had secreted something alkaline, as has been pointed out by JOHNSON ('15) is doubtless, if we see that the pH-value of the distilled water in which the plants grew under the same condition as the others has changed from 5.7 to 6.0. From the fifth day on, as the plants had recovered from unsoundness, rapid change of reaction took place, especially in the case of the NH_4NO_3 -, NH_4Cl - and $(\text{NH}_4)_2\text{SO}_4$ - cultures.

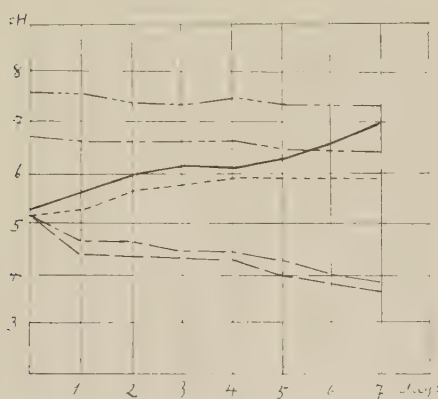


Fig. 1

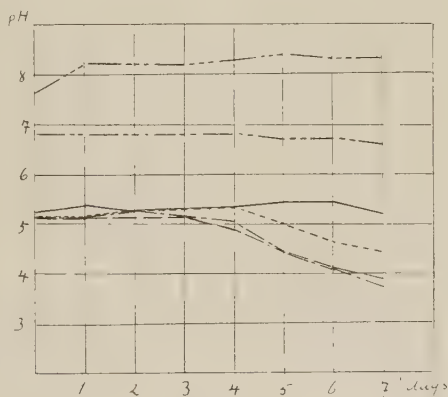


Fig. 3

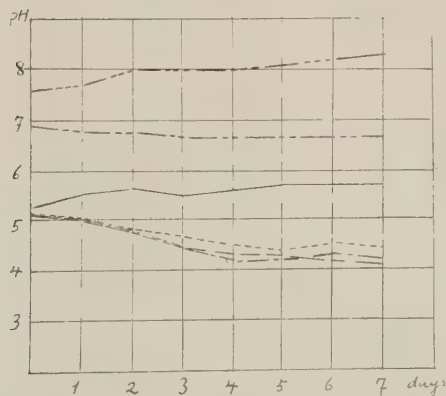


Fig. 2

Fig. 1, *Zea Mays*; Fig. 2, *Oryza sativa*; Fig. 3, *Fagopyrum esculentum*. Curves of daily changes of H-ion concentration in the nutrient solutions supplied with different kinds of N-sources:

— NaNO_3 , NH_4NO_3 ,
 --- NH_4Cl , ——— $(\text{NH}_4)_2\text{SO}_4$
 - - - $(\text{NH}_4)_2\text{HPO}_4$,
 ——— NH_4HCO_3

From the results written above, it will be seen that the seedlings of corn, paddy rice and buckwheat grown in some modified KNOP solution with NaNO_3 , NH_4NO_3 , NH_4Cl , $(\text{NH}_4)_2\text{SO}_4$, $(\text{NH}_4)_2\text{HPO}_4$ and NH_4HCO_3 respectively as the source of nitrogen generally cause similar change of reaction in the culture solutions. In the case of solutions with NH_4NO_3 (with the exception of corn),⁽¹⁾ NH_4Cl and $(\text{NH}_4)_2\text{SO}_4$ as nitrogenous sources, the reaction always becomes more acidic, while the reaction of the solutions containing NaNO_3 always inclines to the neutral point or alkalinity. The hydrogen ion concentration of those solutions with $(\text{NH}_4)_2\text{HPO}_4$ or NH_4HCO_3 as nitrogenous source generally remains constant. The cause of this small change in pH-value is different between these two solutions: in the phosphate-culture the strong buffer action is responsible for it, while in the bicarbonate-culture the escaping of carbon dioxide from the solution prevents it from being changed to extremely acidic. As a proof of the latter statement, a control experiment was carried out in which the daily change of reaction of the NaNO_3 -, NH_4HCO_3 -cultures and distilled water without culture plants was determined. It was found that the solution with NH_4HCO_3 as nitrogenous source became more and more alkaline till on the seventh day its pH-value reached 8.0, while the reaction of NaNO_3 -culture and distilled water made practically no change.

The reaction change above mentioned can be satisfactorily explained only by the theory of unbalanced absorption, or selective absorption. As has been pointed out by OSTERHOUT ('12) and others, if the anions or the cations are absorbed by the plant at an unequal rates, the solution must become alkaline or acidic. In the case of present work, other conditions of the experiment were exactly the same except that sources of nitrogen were different among six kinds of nutrient solution. Accordingly the unequal absorption of the ions of the salts used as nitrogenous sources must account for the different degree of the change of the reaction of the nutrient solutions. For example, when ammonium salts of strong acids such as nitrate, chloride or sulphate were used as nitrogenous sources, the culture plants will absorb NH_3 and OH' in equivalence on the very first. The anions left in the medium combine with the hydrogen ions dissociated from water and thus make the solutions very acidic. Indeed, from Fig. 1, 2 and 3 it will be seen that the rates of reaction change is proportional to the dissociation degrees of these acids. But in the case of NH_4NO_3 , if the anions are preferred by the plant (for example, corn), the reaction of the solution will become more

(1) See foot-note, p. 179.

alkaline. $(\text{NH}_4)_2\text{HPO}_4$ and NH_4HCO_3 , being the ammonium salts of weak acids, act in the same as buffers and the reaction of the solutions containing them is rather constant. On the other hand, the cations of NaNO_3 are very little absorbed by most plants, consequently the nutrient solution with NaNO_3 as nitrogenous source would become less acidic. Thus the direction of the change of hydrogen ion concentration of the nutrient solutions depends in great deal upon the chemical composition of solutions, especially the kinds of salts used as nitrogenous sources, although the special characters of culture plants should be taken into consideration too. Contrary to the above mentioned fact, HOAGLAND ('19) found that, as a results of absorption by barley plant, both alkaline and acidic solutions were brought approximately to the neutral point. DUGGAR ('20) recognized the important relation between the composition and the reaction change of nutrient solutions, though he agrees with HOAGLAND in the conclusion. By growing wheat seedlings in many kinds of nutrient solution, such as KNOP, CRONE, PFEFFER, SACHS etc., JONES and SHIVE ('22a) found that within 52 hours the reaction of these solutions shifted towards neutral point, whatever the initial pH of the solutions may be. In their other studies with wheat ('21) and soybeans ('22b), however, they concluded that the nature of the salt constituents determines the direction of the reaction change of the culture media.

Our results agree with those of PRIANISCHNIKOW ('25) who found that as the results of absorption by seedlings, reaction of the solution of $(\text{NH}_4)_2\text{SO}_4$ changed from pH 6.2 to 3.6 in 24 hours, while that of NaNO_3 of the same initial pH was shifted to pH 6.9.

II. The Influence of Reaction Change of the Nutrient Solutions on the Growth of the Culture Plants

The results of the foregoing experiments have shown clearly that in contact with the root system of the culture plants, the hydrogen ion concentration of the culture solutions becomes either more acidic or more alkaline according to the nature of the salts used as nitrogen sources. That this change of reaction of culture medium due to the unequal absorption has close relation to plant growth may easily be expected, if one thinks of the importance of the influence of hydrogen ion concentration on general life phenomena. In fact, the measurement of growth as well as general observations in the above experiments has shown to some extent the evidence of this supposition. But the shortness of

experimental duration and the daily agitation in pH-determinations of the culture solution made it insufficient to give any definite conclusion. Consequently the experiments of longer duration were carried out with special regard to the effect of change of reaction in culture solution upon the growth of seedlings. The material used in these experiments were seedlings of the following plants:

1. *Zea Mays* (unknown variety)
2. *Fagopyrum esculentum* "California"
3. *Triticum vulgare* "Martins Amber"
4. *Pisum sativum* (unknown variety)
5. *Vicia Faba* (unknown variety)
6. *Oryza sativa* "Hong King Chen" from China.

The duration of the experiment was from two to three weeks, during which time neither renewal of the culture solution nor determination of hydrogen ion concentration was made, though in some cases, distilled water was added to prevent the diminution of quantity of nutrient solution caused by transpiration. With one exception all the experiments were conducted in a greenhouse. Daily observation of growth was made. At the end of the experiment the hydrogen ion concentration of the solution was determined. Except in the case of paddy rice, the residual endosperms or cotyledons of the seedlings were picked off.

EXP. 4. *Zea Mays*.

Culture vessels used were ERLLENMEYER flasks, each containing 270 cc. of nutrient solutions. The composition and concentration of the culture solutions was as follows:

N-sources in the solution	Stock solution		Sum (cc.)	pH
	A (cc.)	B (N-source) (cc.)		
NaNO ₃	50	50	1500	5.2
NH ₄ NO ₃	"	"	"	5.1
NH ₄ Cl	"	"	"	"
(NH ₄) ₂ SO ₄	"	"	"	"
(NH ₄) ₂ HPO ₄	"	"	"	6.8
NH ₄ HCO ₃	"	"	"	7.6

This experiment was carried out near the window of the corridor under direct and sometimes in diffused light. The growth of the plants in all the cultures was excellent at first, but the plants in the two solutions containing NH₄Cl and (NH₄)₂SO₄ grew weaker on the sixth day

after the beginning of the experiment; the leaves became brownish in color and the roots were short, the plants began to lose turgidity. This unsound appearance became more and more serious until at last on the 15th day the plants in one of the $(\text{NH}_4)_2\text{SO}_4$ -culture withered and the experiment had to be discontinued. Among the seedlings grown in the cultures besides the above mentioned two, those in the solutions containing NaNO_3 and NH_4NO_3 showed the best growth, though the growth of those plants in $(\text{NH}_4)_2\text{HPO}_4$ - and NH_4HCO_3 -cultures was quite good. The details of the results of this experiment are shown in Table IV.

TABLE IV

Zea Mays: 3 plants in each culture containing 270 cc. of nutrient solution.
Culture duration: Aug. 14-28, 1924. Temp. 21-29°C

Kinds of N-sources in the solution	Growth			pH	
	Length of shoot (cm)	Green weight (gm)	Dry weight (gm)	initial	final
NaNO_3	26.2	4.668	0.405	5.2	6.8
NH_4NO_3	28.2	5.161	0.426	5.1	6.6
NH_4Cl	21	3.069	0.300	5.1	3.2
$(\text{NH}_4)_2\text{SO}_4$	20	2.559	0.273	5.1	4.0
$(\text{NH}_4)_2\text{HPO}_4$	24	3.513	0.361	6.8	6.0
NH_4HCO_3	22.8	3.313	0.323	7.6	7.1

From this Table we find that the reaction of those two solutions, in which poor growth took place, became highly acidic, while that of the other solutions is nearly neutral.

EXP. 5. *Fagopyrum esculentum*.

The concentration and composition of the nutrient solutions were the same as in the foregoing experiment.

The seedlings in NaNO_3 -, NH_4Cl - and $(\text{NH}_4)_2\text{SO}_4$ -cultures grew fairly and equally good at first. But in contrast to the progressing growth of the plants in the solution of NaNO_3 , the plants in the other solutions grew a little weaker as the experiment drew near the end; the stems were slender and the color of the leaves a little paler. The plants in the other solutions which contained nitric nitrogen began to flower at the end of the experiment, while those in NH_4Cl - and $(\text{NH}_4)_2\text{SO}_4$ -cultures did not. As to the plants in the two solutions supplied with $(\text{NH}_4)_2\text{HPO}_4$ and NH_4HCO_3 , they made practically little or no growth at all. Their

appearance was as poor as those grown in distilled water. The newly grown leaves showed a symptom of chlorosis. The root system of the plants in the two last-mentioned solutions became reddish in color after 24 hours in the solutions and this color became deeper and deeper; at the end of the experiment, it became dark brown or rusty. The measurement of the growth as well as the determinations of final pH are shown in the Table V.

TABLE V

Fagopyrum esculentum: 3 plants in each culture containing 400 cc. of nutrient solution. Sept. 11-30, 1924. Average temp. 20°C

Kinds of N-sources in the solution	Dry weight		pH	
	shoot	root	initial	final
NaNO ₃	0.269	0.038	5.2	5.3
NH ₄ NO ₃	0.242	0.038	5.1	4.4
NH ₄ Cl	0.128	0.037	5.1	3.5
(NH ₄) ₂ SO ₄	0.140	0.032	5.1	3.7
(NH ₄) ₂ HPO ₄	0.120	0.024	6.8	6.7
NH ₄ HCO ₃	0.109	0.028	7.6	8.4

EXP. 6. *Triticum vulgare*, "Martins Amber."

The noteworthy point of the growth feature of the seedlings is the appearance of the roots. Those in the solutions whose reaction became highly acidic as the result of the unbalanced absorption, that is, in the

TABLE VI

Triticum vulgare: 6 plants in each culture containing 270 cc. of nutrient solution. Sept. 13-Oct. 3, 1924. Average temp. 21°C

Kinds of N-sources in the solution	Dry weight (gm)		Length in cm.		pH	
	shoot	root	shoot (aggre- gated)	root	initial	final
NaNO ₃	0.124	0.027	55	11.7	5.2	6.7
NH ₄ NO ₃	0.109	0.022	47	6.7	5.1	4.2
NH ₄ Cl	0.087	0.018	33.3	6.7	5.1	3.0
(NH ₄) ₂ SO ₄	0.091	0.019	35.3	5.3	5.1	3.0
(NH ₄) ₂ HPO ₄	0.121	0.026	51	12.7	6.8	5.3
NH ₄ HCO	0.108	0.022	45	9.7	7.6	8.1

solutions with NH_4NO_3 , NH_4Cl and $(\text{NH}_4)_2\text{SO}_4$ as nitrogenous sources, were short, rich in root hairs. The root system in the solutions relatively less acidic was fine and long. Among those cultures the root growth in the solutions containing $(\text{NH}_4)_2\text{HPO}_4$ was particularly good. Generally the growth of the shoots was parallel to that of the roots, these in the solution containing NH_4Cl or $(\text{NH}_4)_2\text{SO}_4$, whose pH reached 3.0 at the end of the experiment, had the shortest length and the least dry weight (see Table VI); the color of their leaves appeared pale yellow at first and became yellowish brown at last.

EXP. 7. *Pisum sativum*.

The composition and concentration of the nutrient solution were exactly the same as those used in the foregoing cases, except that in this experiment ferric sulphate was used instead of ferrous sulphate as source of iron.

TABLE VII

Pisum sativum: 3 plants in each culture containing 400 cc. of nutrient solution. Oct. 2-13, 1924. Average temp. 19°C

Kinds of N-sources in the solution	Dry weight (gm)		Length of shoot (cm)	Growth of lateral root	pH	
	shoot	root			initial	final
NaNO_3	0.215	0.074	15.3	+++	5.2	6.2
NH_4NO_3	0.174	0.068	13	+	5.1	4.0
NH_4Cl	0.164	0.055	10	+	5.1	3.9
$(\text{NH}_4)_2\text{SO}_4$	0.160	0.053	11	++	5.1	3.9
$(\text{NH}_4)_2\text{HPO}_4$	0.195	0.066	13	+++	6.8	6.1
NH_4HCO_3	0.156	0.059	10.7	+	7.6	8.0
dist. water	0.162	0.063	12	++	5.7	5.2

The growth in general was poor; the leaf blades were small and the shoots were slender. On the 12th of October, nodule bacteria appeared in the root system of the seedlings, and the experiment had to be discontinued. In concordance with the foregoing results the pea seedlings made favorable growth in those solutions whose reaction did not become very acidic. The root system in such solutions was rich in lateral rootlets and white in color. On the other hand, the root system in the other solutions containing NH_4NO_3 , NH_4Cl and $(\text{NH}_4)_2\text{SO}_4$, whose pH-values were nearly 4.0 at the end of the experiment, became reddish brown and had less lateral rootlets. As it will be seen from Table VII, the plants in such acidic solutions were equal in dry weights to those

grown in distilled water. The plant growth in the solution containing NH_4HCO_3 was by no means good.

EXP. 8. *Vicia Faba*.

The composition and concentration of the nutrient solution were exactly the same as those in the foregoing pea-culture.

TABLE VIII

Vicia Faba: 3 plants in each culture containing 400 cc. of nutrient solution. Oct. 22—Nov. 10, 1924. Average temp. 15°C

Kinds of N-sources in the solution	Dry weight (gm)		Length of shoot (cm)	Growth of lateral root	pH	
	shoot	root			initial	final
NaNO_3	0.189	0.095	13.3	+++	5.2	4.2
NH_4NO_3	0.163	0.091	10.7	++	5.1	3.8
NH_4Cl	0.159	0.088	8.3	+	5.1	3.7
$(\text{NH}_4)_2\text{SO}_4$	0.159	0.080	9.3	+	5.1	3.7
$(\text{NH}_4)_2\text{HPO}_4$	0.179	0.090	11.7	+++	6.8	5.9
NH_4HCO_3	—	—	—	—	7.6	8.4

As in the case of the pea, the growth of seedlings in this experiment was not very good. In general, the leaf blade was small and pale green in color. In the solutions whose pH-value had shifted from 5.1 to 3.7, the dry weight of the seedlings and the growth of their lateral rootlets were inferior to those grown in the solutions less acidic (Table VIII). High concentration of hydrogen ion of the culture media had some effect on the root color besides on the growth of lateral rootlets: in the extremely acidic solutions, it was dark gray, while in the moderate acidic ones, it was white or reddish white. The alkaline reaction of the solutions containing NH_4HCO_3 seems decidedly toxic to the young seedlings. They made no growth and the color of their leaves turned to black on the 9th day of the experiment. Five days later all of the plants were found wilted without a single exception. The root system decayed at the same time, and any measurement became impossible.

It should be pointed out that as in the case of the buckwheat, the seedlings of *Vicia Faba*, grown in the solutions containing NaNO_3 , shifted the acidity of the solution from pH 5.2 to 4.2. Expecting that the accumulation of CO_2 might be the cause of this strange phenomenon, CO_2 -free air was bubbled through the medium in order to drive CO_2 out of the solutions. The pH-value of the CO_2 -free solution was found to

be 4.6, still a little more acidic than the initial. Tests for oxalic acid, one of the probable organic products, resulted in the negative. From the fact that the final reaction of pure water was less acidic than that of the solution containing NaNO_3 , the theory of the excretion of acidic substances by plants is insufficient for the explanation of this phenomenon. Probably the seedlings of *Vicia Faba* absorb the Na -ions with same or even greater velocity as NO_3 -ions. But any satisfactory conclusion requires further studies.

EXP. 9. *Oryza sativa*.

The nutrient solutions used in this experiment are somewhat different in concentration and iron source. Their composition is as follows:

N-sources in the solution	Stock solution		Sum (cc.)	pH
	A (cc.)	B (N-source) (cc.)		
NaNO_3	50	50	1000	5.2
NH_4NO_3	"	"	"	5.1
NH_4Cl	"	"	"	"
$(\text{NH}_4)_2\text{SO}_4$	"	"	"	"
$\text{NH}_4\text{H}_2\text{PO}_4$	"	"	"	5.6
NH_4HCO_3	"	"	"	7.6

5 drops of 0.5% FeCl_3 solution were added to every litre of the above mentioned nutrient solutions.

The seeds used in this experiment are from a variety of paddy rice widely cultivated in the eastern region of Chiekiang Province, China.

TABLE IX

Oryza sativa: 6 plants in each culture containing 400 cc. of nutrient solution. June 24–July 13, 1925. Temp. 30–16°C

N-sources in the solution	Dry weight (gm)		Length (cm)		pH	
	shoot	root	shoot	root	initial	final
NaNO_3	0.0519	0.0738	10	13	5.2	6.0
NH_4NO_3	0.3728	0.1160	25	12	5.1	3.1
NH_4NO_3	0.1893	0.0805	18	8	5.1	2.8
$(\text{NH}_4)_2\text{SO}_4$	0.2177	0.0887	20	7	5.1	2.9
$\text{NH}_4\text{H}_2\text{PO}_4$	0.1163	0.0718	15	14	5.6	4.1
NH_4HCO_3	0.0365	0.0620	8	3	7.6	8.5

The growth of plants grown in NH_4NO_3 -, NH_4Cl - and $(\text{NH}_4)_2\text{SO}_4$ -cultures whose acidity increased rapidly, was very excellent. Alkaline solutions or the solution whose reaction changes gradually from acidic to alkaline, is unsuitable for the growth of paddy rice seedlings. The plants in NH_4HCO_3 -culture did not grow from the very first of the experiment and wilted soon. The plants in NaNO_3 -culture, though they grew fairly well at first, became chlorotic and ceased to grow at the middle of the experiment in spite of the good development of the roots. This result agrees with that of NAGAOKA ('04), who found that paddy rice plants could not assimilate nitric nitrogen so good as they utilize ammoniacal nitrogen. The plant growth in the solutions containing $\text{NH}_4\text{H}_2\text{PO}_4$ was by no means good; the leaf tip became white at first and the green color disappeared from the whole plant at last. As the pH-range of $\text{NH}_4\text{H}_2\text{PO}_4$ -culture is not unsuitable for paddy rice, we have to ascribe the superabundance of phosphates as the cause of this characteristic symptom. We will come to this point later.

From the above results, it will be seen that the effects of change of reaction of culture medium due to the unbalanced absorption by the seedlings, are generally in the same manner with different kinds of plant material. In all cases, the high acidity of the NH_4NO_3 -, NH_4Cl - and $(\text{NH}_4)_2\text{SO}_4$ -cultures caused inferior growth; and the solution containing NH_4HCO_3 also inhibited the plant growth with its increasing alkalinity, though the seedlings of wheat and corn could grow in it tolerably good. $(\text{NH}_4)_2\text{HPO}_4$ and $\text{NH}_4\text{H}_2\text{PO}_4$ with their strong buffer action are the suitable nitrogenous sources for most plants except buckwheat and paddy rice, and the slow inclination to alkalinity in the solution containing NaNO_3 produced favorable growth in most cases (at least in the early stage of plant growth).

The influence of hydrogen ion concentration upon the seedlings grown in culture solutions has been extensively studied by many authors. KOJI MIYAKE ('14) has grown paddy rice plants in solutions of H_2SO_4 , HCl , KOH , NaOH , Na_2SO_4 , NaCl , K_2SO_4 , KCl respectively and found that H-ion is much more toxic than OH-ion for the growth of the rice plant. HOAGLAND ('17), by growing barley seedlings in a series of solutions of different hydrogen ion concentration containing a mixture of K_3PO_4 and K_2HPO_4 in different proportions, found that OH-ion greater than approximately 2.5×10^{-5} ⁽¹⁾ is extremely toxic, while acid condition is favorable for the growth of

(1) This value, when expressed in terms of pH, is 9.4.

seedlings in concentration as high as 0.7×10^{-5} ⁽¹⁾ H-ion. SALTER and McILVAINE ('20) found that a reaction of pH 5.94 to 5.16 is favorable for the growth of seedlings of wheat, soybeans, alfalfa and corn. The experimental data written above are generally in agreement with those of HOAGLAND as well as SALTER and McILVAINE in this respect. With the exception of wheat and corn, a solution of initial pH 7.4 was alkaline enough for the inhibition of the growth of young plants used in the whole work, though all plants could grow more or less favorably in solutions as acidic as pH 4.0.

The above results show also that plants are different in resistance to acidity and alkalinity; wheat and corn prefer weak alkalinity and could not make normal growth in the highly acidic solution about pH 4.0. On the contrary, paddy rice and buckwheat can grow in acid solution quite well, but are very sensitive to alkalinity, an initial pH of 7.6 would cause the inhibition of growth.

It is clear from the results of these experiments that the inferiority of ammonium salts to NaNO_3 as the source of nitrogen for higher plants may be in some respects due to the unfavorable effect of increased acidity or alkalinity in the culture solution caused by unbalanced absorption of ions. As will be seen in the latter part of this work, the ammonium salts are quite as good sources of nitrogen as nitrate, if the increasing acidity of the nutrient solution could be avoided. From the manner of change of reaction in the solution containing NH_4NO_3 , we can see that with the solitary exception of corn,⁽²⁾ plants do not prefer nitrate ion to ammonium one. Thus speaking of nutrition, it must be an unnegligible moment that the change of reaction of culture medium should always be taken into consideration.

III. Effect of Combination of Ammonium Salts as Nitrogenous Source upon Plant Growth and Reaction Change

The results of experiments described thus far has ascertained the fact that by growing plants in those solutions with NH_4Cl and $(\text{NH}_4)_2\text{SO}_4$ as nitrogenous sources, the culture medium always becomes highly acidic, so that most plants could hardly grow in them. It is also true that solutions containing $(\text{NH}_4)_2\text{HPO}_4$ undergo little or no change of reaction

(1) This value, when expressed in terms of pH, is 4.845

(2) The further study now in progress shows, however, that the reaction change in the NH_4NO_3 -culture of corn goes sometimes in the same manner as in the case of the other plants (added at the time of proof-reading).

and that the solution with NH_4HCO_3 as nitrogenous source generally becomes remarkably alkaline due to the escaping of carbon dioxide. Now if instead of single ammonium salt a combination of two salts, for example, NH_4Cl and NH_4HCO_3 mixed were used as nitrogenous source, the result may be otherwise. For instance, in a series of solutions with combinations of NH_4Cl and $(\text{NH}_4)_2\text{HPO}_4$ in varied proportions, those solutions with greater quantity of $(\text{NH}_4)_2\text{HPO}_4$ must have stronger buffer action. If in such solutions wheat seedlings were grown, the seedlings would make better growth in the solutions of stronger buffer action. In order to make sure of the above supposition, two experiments were carried out with buckwheat and wheat.

These experiments were worked out in a greenhouse. pH-determinations were made at the beginning and the end of the experiment. No renewal of nutrient solutions was made during the experiment though distilled water was added from time to time.

EXP. 10. *Fagopyrum esculentum*.

The composition of the nutrient solutions used in this experiment was as follows:

Series No.	Stock solution A (cc)	Nitrogenous sources				Sum (cc.)	pH
		NaNO_3 (cc.)	NH_4Cl (cc.)	$(\text{NH}_4)_2\text{HPO}_4$ (cc.)	NH_4HCO_3 (cc.)		
1	50	50	0	0	0	3000	5.2
2	"	0	37.5	12.5	0	"	6.2
3	"	0	12.5	37.5	0	"	6.6
4	"	0	37.5	0	12.5	"	7.0
5	"	0	25.0	0	25.0	"	7.1
6	"	0	12.5	0	37.5	"	7.2

Iron was added to the nutrient solutions in the form of ferric sulphate.

At first, the plants in series 2 made the most favorable growth, even better than the plants in NaNO_3 -culture. This phenomenon, however, did not last long, and soon after the plant growth in all cultures appeared equal in degree of development. The root system of the plants in those more alkaline solutions grew very little, their color became rusty or pink. This unsoundness of root system, together with the precipitation of iron due to the extreme alkalinity, caused the poor growth of the plants in the solutions containing the least amount of NH_4Cl and the greatest quantity of NH_4HCO_3 . At the end of the experiment the plant growth in the solutions containing NaNO_3 and the

combination of NH_4Cl and $(\text{NH}_4)_2\text{HPO}_4$ appeared equally good, while the plants in the series 4, 5 and 6 were poorer in appearance. Among the latter three solutions, series 5 produced favorable growth. In one of the cultures of series 4, the growth was inhibited by some unknown cause. On examining the root system it was found that the roots were deep brown in color as if they had grown in an extremely alkaline solution. The results of this experiment are shown in the Table X.

TABLE X

Fagopyrum esculentum: 4 plants in each culture containing 270 cc. of nutrient solution. Oct. 5-24, 1924. Temp. 19°C.

Series No.	Dry weight (gm)		Length of shoot (cm)	pH	
	shoot	root		initial	final
1	0.119	0.016	15.3	5.2	4.8
2	0.097	0.020	15.7	6.2	3.6
3	0.099	0.021	15	6.6	4.9
4	0.081	0.020	14	7.0	7.0
5	0.084	0.021	15	7.1	7.5
6	0.081	0.018	13	7.2	7.9

EXP. 11. *Triticum vulgare*, "Martins Amber."

Fifteen plants were grown in each culture vessel containing 400 cc. of nutrient solution.

Series No.	Stock solution A (cc.)	Nitrogenous sources				Sum (cc.)	pH
		NaNO_3 (cc.)	$(\text{NH}_4)_2\text{SO}_4$ (cc.)	$(\text{NH}_4)_2\text{HPO}_4$ (cc.)	NH_4HCO_3 (cc.)		
1	10	10	0	0	0	400	5.2
2	"	0	8	0	2	"	6.8
3	"	0	6	0	4	"	7.0
4	"	0	4	0	6	"	7.2
5	"	0	2	0	8	"	7.4
6	"	0	8	2	0	"	6.0

In the first week of the experiment, the plant growth in the NaNO_3 -culture and in series 6 surpassed that in all other solutions. From this time on, the development of the plants in the latter solutions became slower and slower while the plants in the NaNO_3 -culture grew with increasing rapidity. On the 7th of November the growth feature of the plants in series 2 was the best of all, only a little inferior to the plants

in the solution containing NaNO_3 . Next to this, the plant growth in series 4 was better than that in series 5, which was in turn superior to that in series 2. On examining the hydrogen ion concentration of the nutrient solutions, it was found that the pH-values of series 2 and 6 had shifted from 6.0 or 6.8 to 3.0 and that hydrogen ion concentration of other solutions was nearly neutral. One week later, the plants in series 5 grew rapidly and on the 20th of November showed the best growth over all other cultures. But this superiority did not last long, and within a few days, the rate of growth was lowered again. At this time, the plants in series 2 and 6 had decidedly withered and symptom of injuries due to higher acidity appeared on the leaves and roots of the plants in series 3.

TABLE XI

Triticum vulgare: 15 plants in each culture containing 400 cc. of nutrient solution. Oct. 23–Dec. 5, 1924. Temp. 19°C.

Series No.	Dry weight (gm)		pH		
	shoot	roots	initial	Nov. 7	final
1	0.6180	0.1840	5.2	7.0	7.4
2	0.3215	0.1090	6.8	3.0	3.0
3	0.3620	0.1170	7.0	6.0	3.2
4	0.4560	0.1390	7.2	6.8	3.4
5	0.5000	0.1390	7.4	7.1	3.6
6	0.2460	0.1080	6.0	3.0	3.0

This experiment was interrupted on the 5th of December. As will be seen from Table XI and Fig. 4, the final reaction of all nutrient solutions became greatly acidic except the NaNO_3 -culture, which changed to alkaline. It is interesting to see that the degree of acidity resulting from the unbalanced absorption of ions by plants is in direct proportion to the amount of ammonium sulphate; the larger the amount of sulphate, the higher the acidity. The dry weight of the plants is inversely proportional to the acidity of the culture medium; the more acidic the reaction of the solution, the less the dry weight.

The plants in the solution containing NaNO_3 attained the best growth and the greatest dry weight. But from the declining growth feature at the end of this experiment and the final pH of the solution, it is with reasonable certainty to conclude that the increasing alkalinity

would ultimately inhibit the growth of plants, if the experiment had been carried on a little longer.

The results of these two experiments show clearly the mutual influence between plant growth and reaction change of the culture solution. In a solution having the initial pH suitable for plant growth, the plants grow with great rapidity at first, so that the reaction of the solution changes greatly within a short time. This reaction change, in turn, often gives unfavorable effect on the plant growth; thus a maximum growth at the beginning may be followed by poorest results. On the

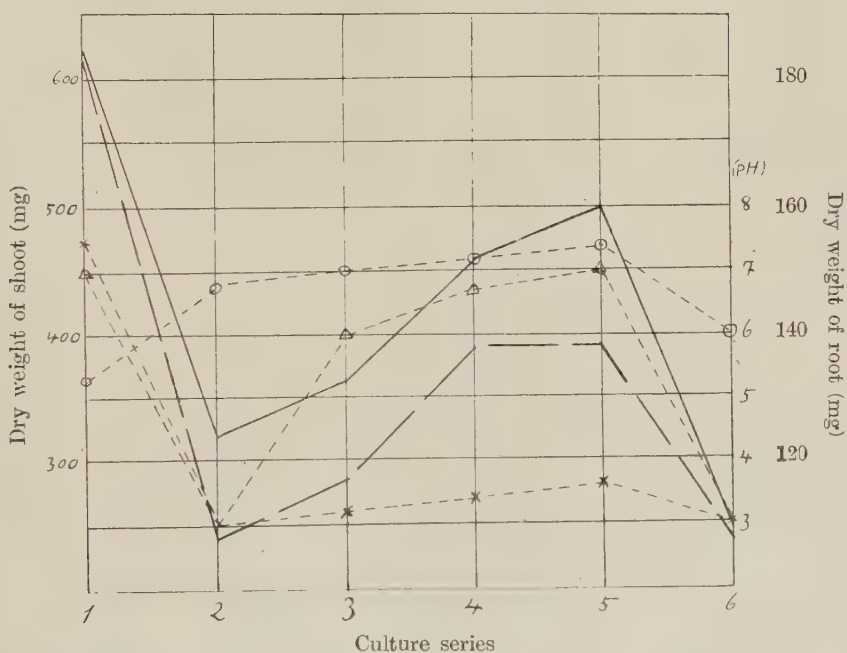


Fig. 4. *Triticum vulgare*

—— Dry weight of shoot. ○——○ initial pH
 ——— Dry weight of root. △——△ pH on 7th of Nov.
 ×——× final pH.

other hand, plants will grow with difficulty in such solution whose initial pH does not suit the growth. But on the midway of the experiment, when the pH-value is shifted to some point near to the optimum one, the growth will be suddenly accelerated until at last this extreme reaction change due to rapid absorption causes its inhibition. Thus different types of growth feature may take place in solutions having

different degree of buffer action and containing different composition. Therefore on the comparative study of the growth of plants, attentions should be paid to the growth stage, reaction change of the culture medium as well as its buffer action. SAKAMURA ('24) calls attention to the importance of the buffer action of the medium and regards the measurement of initial pH of the solution without any consideration of the reaction change as meaningless. In Experiment 11 (*Triticum vulgare*) the initial pH 5.2 of the solution may be shifted to pH 7.4, while a solution of initial pH 7.4 may become extremely acidic. If only initial pH of the culture medium were taken into account, it should be concluded from the results of the last experiment that wheat seedlings could not grow in a solution less acidic than that with an initial pH 6.0; a conclusion quite contrary to the fact. The measurement of initial and final pH without any regard to the buffer action is also meaningless. For example, in Table XI, both the solutions having the initial pH 6.8 and 6.0 became pH 3.0 on the 7th of November, though it is doubtless that series 6 reached this acidic point earlier than the other. Of course, the initial pH of the culture medium has important influence on the early stage of plant growth; a solution with an unfavorable initial pH and strong buffer action would cause the inhibition of growth at the very beginning of the culture. The results of the experiment with buckwheat furnish a good example for the above statement; the initial pH of the three solutions containing NH_4Cl and NH_4HCO_3 combined were not fit for plant growth, though these solutions possessed good buffer power respectively. Thus only those solutions both with favorable initial pH and favorable buffer power are capable of producing the optimum growth.

IV. The Influence of Phosphates on the Reaction Change and Plant Growth

As mentioned above, the unfavorable effect of the reaction change of culture solution upon plant growth may be avoided or at least diminished by using a combination of ammonium salts as nitrogenous source instead of single one. We have ascribed this beneficial effect to the buffer action of ammonium bicarbonate and biphosphate. If this statement is correct, some salts of phosphoric acid other than ammonium salts also should react in the same way. In order to bring this point to light, the following experiments were carried out. Here the influence of sodium phosphates was studied. M/10 solution of Na_2HPO_4 (KAHLBAUM, pro analysis) and NaH_2PO_4 (MERCK, extra pure) were used

throughout these experiments. No renewal of culture solutions was made during the experiments.

EXP. 12. *Triticum vulgare*.

The composition of the nutrient solutions was as follows:

Series No.	Stock solution A (cc)	Nitrogenous sources				Na ₂ HPO ₄ (cc)	Sum (cc)	pH
		NH ₄ Cl (cc)	(NH ₄) ₂ SO ₄ (cc)	NH ₄ H ₂ PO ₄ (cc)	NaNO ₃ (cc)			
1	50	50	0	0	0	0	1000	5.3
2	„	0	50	0	0	0	„	„
3	„	0	0	50	0	0	„	5.7
1'	„	50	0	0	0	50	„	7.2
2'	„	0	50	0	0	50	„	7.2
3'	„	0	0	50	0	50	„	6.4
Control	„	0	0	0	50	0	„	5.4

At first, all the plants grew quite well, but a week after the beginning of the experiment, the difference of growth between the plants in the solutions with and without sodium phosphate was recognizable; those in the solutions without sodium phosphate showed symptom of chlorosis

TABLE XII

Triticum vulgare: Five plants in each culture containing 270 cc. of nutrient solution. June 15–July 3, 1925. Temp. 21°C.

Series No.	Dry weight (gm)		Length (cm)		pH		
	shoot	root	shoot	root	initial	June 22	final
1	0.1276	0.0273	41	8	5.3	3.2	3.0
2	0.1202	0.0275	41	8	5.3	3.3	3.0
3	0.1609	0.0341	54	11	5.7	3.6	3.4
1'	0.1718	0.0348	58	13	7.2	6.8	6.6
2'	0.1812	0.0373	56	13	7.2	6.8	6.5
3'	0.1901	0.0417	55	13	6.4	6.2	6.0
Control	0.2064	0.0559	60	21	5.4	6.0	6.7

From Table XII, we see that the reaction change in the solutions of series 1', 2' and 3' was retarded by the addition of sodium phosphate and that the seedlings grew much better in those solutions than those in the solutions without it. Among the plants in the solutions containing Na₂HPO₄ those

in series 3' attained the greatest dry weights. Perhaps the slight alkalinity of the initial reaction had something to do with the inferior growth of the plants in series 1' and 2'.

EXP. 13. *Zea Mays*.

The composition of the nutrient solutions used in this experiment was as follows:

Series No.	Stock solution		Na ₂ HPO ₄ (cc)	Sum (cc)	pH
	A (cc)	B (cc)			
1	50	50(NaNO ₃)	0	1000	5.2
2	"	„(NH ₄ H ₂ PO)	25	"	6.2
3	"	„ („)	37.5	"	6.4
4	"	„ („)	50	"	6.5
5	"	„ („)	62.5	"	6.6
6	"	„ („)	76	"	6.7

The growth feature in all solutions was good. The plants in series 5 and 6 did not grow very rapidly at first, though the growth was accelerated near the end of this experiment. On the contrary, the plants in series 2 and 3 grew very fast at the beginning, but ceased to do so in a very short time.

TABLE XIII

Zea Mays: 2 plants in each ERLNMEYER flasks containing 270 cc. of nutrient solution. July 7-25, 1925. Temp. 20°-28°C.

Series No.	Dry weight (gm)		Length of shoot (cm)	pH	
	shoot	root		initial	final
1	0.5817	0.3360	46	5.2	7.6
2	0.4110	0.3100	40	6.2	3.2
3	0.4570	0.2980	42	6.4	3.5
4	0.4905	0.2495	40	6.5	4.5
5	0.5170	0.2980	38	6.6	5.0
6	0.4930	0.2340	42	6.7	5.3

The results of this experiment, as shown in the Table XIII, is in concordance with that of the foregoing one; namely: the plant growth in those solutions which contain more Na₂HPO₄, consequently stronger buffer action, is better than that in the solutions with smaller quantity of Na₂HPO₄.

The results of the above two experiments show clearly the beneficial influence of Na_2HPO_4 in those solutions whose reaction becomes incessantly acidic. The reaction of the solutions containing Na_2HPO_4 changed but very little when compared to that of the solutions with small amount of or no Na_2HPO_4 and in the plants in these solutions we see the best growth.

In the last experiment, the amount of Na_2HPO_4 was different in the series of culture solutions, the series 2 contains the least amount and series 6 the largest. Therefore besides the effect of buffer action, the influence of concentration of nutrient salts, especially the effect of Na-ion, must be taken into account. In fact, the plant growth of the series 6 is inferior to that of series 5.

In order to make sure the relation between plant growth and the buffer action of the culture solution, the following experiments were carried out in which a combination of Na_2HPO_4 and NaH_2PO_4 was used as buffer instead of adding the different amount of Na_2HPO_4 to the culture solution. As culture plants, seedlings of corn, wheat, lupine, Azuki-bean and paddy rice were used.

Exp. 14. *Zea Mays*.

As culture vessels cylinder made of Jena glass were used. The composition and concentration of the culture solutions are as follows:

Series No.	Stock solution		Na_2HPO_4 (cc)	NaH_2PO_4 (cc)	Sum (cc)	pH
	A (cc)	B (cc)				
1	50	50 (NaNO_3)	0	0	1000	5.2
2	"	" (NH_4Cl)	50	0	"	7.2
3	"	" (")	45	5	"	7.1
4	"	" (")	40	10	"	7.0
5	"	" (")	35	15	"	6.9
6	"	" (")	30	20	"	6.8

TABLE XIV

Zea Mays: 3 plants in each culture containing 300 cc. of nutrient solution. July 27—Aug. 15, 1925. Temp. 19°–30°.

Series No.	Dry weight (gm)		pH	
	shoot	root	initial	final
1	0.4501	0.2116	5.2	7.3
2	0.4085	0.1788	7.2	4.4
3	0.3215	0.1497	7.1	4.5
4	0.4691	0.2006	7.0	3.7
5	0.5289	0.1795	6.9	3.3
6	0.4769	0.1900	6.8	3.2

Table XIV shows that series 5 and 6 are most suitable for the growth of *Zea Mays*. In other words, corn seedlings can not grow well enough in the solutions having initial pH greater than 7.0. As the buffer action of series 2 and 3 is stronger than that of series 5 and 6, solutions with stronger buffer action are not necessarily the best solutions for plant growth. In this respect, our result is in concordance with that of WEIS ('19), who found that the seedlings of *Zea Mays* and *Avena sativa* could not grow in the alkaline solutions of strong buffer power, because the plants were unable to bring the pH-value to acidic side. He found also that in the alkaline solutions of weak buffer action, whose pH-values were shifted to 4.5-6.0, the optimum growth of these plants was to be seen.

EXP. 15. *Triticum vulgare*.

The culture solutions were as follows:

Series No.	Stock solution		Na ₂ HPO ₄ (cc)	NaH ₂ PO ₄ (cc)	Sum (cc)	pH
	A (cc)	B (cc)				
1	25	25 (NH ₄ Cl)	25	15	1000	6.6
2	"	" (")	30	10	"	6.7
3	"	" (")	35	5	"	6.8
4	"	" (")	40	0	"	7.0

The results of this experiment are shown in Table XV.

TABLE XV

Triticum vulgare: 5 plants in each culture containing 270 cc. of nutrient solution. July 27-Aug. 14, 1925. Temp. 20°-30°C.

Series No.	Dry weight (gm)		pH	
	shoot	root	initial	final
1	0.2360	0.0573	6.6	4.6
2	0.2768	0.0655	6.7	4.4
3	0.2915	0.0737	6.8	5.0
4	0.2713	0.0623	7.0	5.7

Plant growth in the solution having initial pH 6.8 was the best of all.

Exp. 16. *Lupinus luteus*.

Cylinders made of porcelain were used as culture vessels. The culture media were solutions of the following composition and concentration.

Series No.	Stock solution		Na ₂ HPO ₄ (cc)	NaH ₂ PO ₄ (cc)	Sum (cc)	pH
	A (cc)	B (cc)				
1	20	20 (NaNO ₃)	0	0	400	5.2
2	"	" (NH ₄ Cl)	0	40	"	5.6
3	"	" (")	5	35	"	6.0
4	"	" (")	10	30	"	6.4
5	"	" (")	15	25	"	6.6
6	"	" (")	20	20	"	6.8
7	"	" (")	25	15	"	7.0
8	"	" (")	30	10	"	7.1

This experiment was carried out in a greenhouse. The results are shown in Table XVI.

TABLE XVI

Lupinus luteus: 3 seedlings in each culture containing 400 cc. of nutrient solutions. Sept. 4-29, 1925. Temp. 22°C.

Series No.	Dry weight (gm)		pH	
	shoot	root	initial	final
1	0.4523	0.1007	5.2	4.2
2	0.3763	0.0757	5.6	4.0
3	0.3873	0.0833	6.0	5.0
4	0.4015	0.0940	6.4	5.4
5	0.3150	0.1047	6.6	5.8
6	0.2965	0.0790	6.8	6.4
7	0.3078	0.0790	7.0	6.6
8	0.2912	0.0761	7.1	6.8

Plant growth in series 4 was the best of all. The growth feature of root system seems to have some close relation with the acidity of the culture solution: those in the acidic solutions were long and fine, while in the alkaline solutions they were short and thick.

EXP. 17. *Phaseolus Mungo* var. *subtrilobata*, "Maruba".

The nutrient solutions used have the following composition and

concentration:

Series No.	Stock solution		Na ₂ HPO ₄ (cc)	NaH ₂ PO ₄ (cc)	Sum (cc)	pH
	A (cc)	B (cc)				
1	20	20((NH ₄) ₂ SO ₄)	0	0	400	5.0
2	"	" (")	10	40	"	6.5
3	"	" (")	15	35	"	6.7
4	"	" (")	20	30	"	6.8
5	"	" (")	25	25	"	6.9
6	"	" (")	30	20	"	7.1
7	"	" (")	35	15	"	7.2
8	"	" (")	40	10	"	7.3
9	"	" (NaNO ₃)	0	0	"	5.1

TABLE XVII

Phaseolus Mungo Var. *subtrilobata*: 3 plants in each porcelain jar containing 400 cc. of nutrient solution. Nov. 3—17, 1925. Temp. 18°C.

Series No.	Dry weight (gm)		Length (cm)		pH		Nessler's reaction
	shoot	root	shoot	root	initial	final	
1	0.1893	0.0747	18	14	5.0	3.4	+++
2	0.1813	0.0612	21	14	6.5	6.2	+
3	0.1950	0.0512	21	15	6.7	6.4	++
4	0.2139	0.0755	24	15	6.8	6.5	++
5	0.1843	0.0622	22	15	6.9	6.5	±
6	0.2065	0.0695	24	13	7.1	6.7	+
7	0.2458	0.0772	26	15	7.2	6.8	++
8	0.2305	0.0637	25	15	7.3	6.9	++
9	0.2205	0.0575	27	16	5.1	4.4	

As will be seen from the above Table, the maximum growth took place in series 7 and 8 which contained the greatest amount of Na₂HPO₄.

EXP. 18. *Oryza sativa*, "Hung King Chen."

The culture solutions used were as follows:

Series No.	Stock solution		NaH ₂ PO ₄ (cc)	Na ₂ HPO ₄ (cc)	Sum (cc)	pH
	A (cc)	B (cc)				
1	20	20 (NaNO ₃)	0	0	400	5.2
2	„	„ (NH ₄ Cl)	40	0	„	5.6
3	„	„ („)	37.5	2.5	„	5.9
4	„	„ („)	35	5	„	6.1
5	„	„ („)	32.5	7.5	„	6.3
6	„	„ („)	30	10	„	6.4

This experiment was conducted in a greenhouse.

Growth in general was unsatisfactory. The plants in NaNO₃-culture (series 1) became chlorotic, though the development of root system was quite good. Whitening of leaf-tips occurred uniformly in all plants from series 2 to 6 on the third day of the experiment and this characteristic symptom gradually progressed till the whole leaf-blade became white. This abnormality is the same with that which appeared on the plants in the NH₄H₂PO₄-culture described in Exp. 9. Perhaps the superabundance of phosphates in the solutions is the cause of this phenomenon. The results of the following two experiments on paddy rice will bring this point to light.

TABLE XVIII

Oryza sativa: 6 plants in each culture containing 400 cc. of nutrient solution. Aug. 4-19, 1925. Temp. 25°C

Series No.	Dry weight (gm)		pH	
	shoot	root	initial	final
1	0.1210	0.0797	5.2	6.4
2	0.1656	0.0808	5.6	3.9
3	0.1718	0.0744	5.9	4.6
4	0.1356	0.0807	6.1	5.3
5	0.1152	0.0776	6.3	5.8
6	0.0850	0.0676	6.4	6.2

From the above Table, it will be seen that plant growth was the best in those solutions having the weakest buffer action. The results of this experiment furnish another proof for the fact that for the growth of paddy rice plant solutions of acidic reaction are more suitable than alkaline one, and that, when pH-values are not fit for plant growth,

solutions having strong buffer action are more injurious for plant growth than those with moderate one.

From the foregoing data, it will be seen that in the solution with NH_4Cl or $(\text{NH}_4)_2\text{SO}_4$ as nitrogenous sources, the increase of acidity was retarded by adding phosphates of sodium and that this retardation resulted in a good growth of plants. It was also found that in the solution of stronger buffer capacity, the initial pH of the solution has very great influence upon the plant growth; in the case of those solutions whose initial pH is not fit for growth, solutions of strong buffer action are not the best culture media. For instance, paddy rice plants showed the best growth in the solutions having the least buffer power, because the initial pH-values of the solutions having strong buffer action were not suitable for plant growth. In the last case, the superabundance of phosphates seemed to have peculiar effect on the growth of rice plants. In order to ascertain this fact, the following two experiments were conducted with this plant. Both experiments were worked out in a greenhouse.

EXP. 19. *Oryza sativa*.

It was the aim of this experiment to see whether the characteristic whitening of leaf-blade in paddy rice plants was caused by the superabundance of phosphate only. For this purpose, a special stock solution A' was prepared in which the amount of KH_2PO_4 was greatly increased.

Special stock solution A':

$\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$	2.5 gm.
KH_2PO_4	3.5 „
CaCl_2	0.95 „
Distilled water	500 cc.

The composition of the solutions were as follows:

N-sources in the solution	Stock solution		Sum (cc)	pH
	A' (cc)	B (N-source) (cc)		
NaNO_3	50	50	1000	4.8
NH_4NO_3	„	„	„	4.7
HH_4Cl	„	„	„	4.7
$(\text{NH}_4)_2\text{SO}_4$	„	„	„	4.8
$\text{NH}_4\text{H}_2\text{SO}_4$	„	„	„	5.1
$(\text{NH}_4)_2\text{HPO}_4$	„	„	„	6.5

TABLE XIX

Oryza sativa: 6 plants in each culture containing 300 cc. of nutrient solution. Aug. 17-31, 1925. Temp. 22°C.

Kinds of N-sources in the solution	Dry weight (gm)		pH		Degree of whitening in leaf-blade
	shoot	root	initial	final	
NaNO ₃	0.1337	0.0781	4.8	6.4	+
NH ₄ NO ₃	0.3004	0.0908	4.7	3.4	+
NH ₄ Cl	0.1615	0.0725	4.7	3.0	+
(NH ₄) ₂ SO ₄	0.1788	0.0727	4.8	3.0	+
NH ₄ H ₂ PO ₄	0.1242	0.0696	5.1	3.9	++
(NH ₄) ₂ HPO ₄	0.0739	5.0669	6.5	6.5	+++

The characteristic symptom appeared on the third day of experiment on every plant without a single exception. Notwithstanding the good development of the root system, the seedlings did not grow.

EXP. 20. *Oryza sativa*.

In this experiment a combination of (NH₄)₂SO₄ and NH₄H₂PO₄ was used as nitrogenous source. The composition of the solutions was as follows: .

Series No.	Stock solution			HCl (N/100) (cc)	Sum (cc)	pH
	A' (cc)	B (cc)				
		(NH ₄) ₂ SO ₄	NH ₄ H ₂ PO ₄			
1	70	70	0	0.55	1400	4.3
2	”	60	10	1.85	”	”
3	”	50	20	3.5	”	”
4	”	40	30	4.75	”	”
5	”	30	40	5.8	”	”
6	”	20	50	7.0	”	”
7	”	10	60	8.1	”	”
8	”	0	70	9.1	”	”

As shown above, the initial pH of all culture solutions was adjusted with N/100 HCl to bring it to pH 4.3, a value which was found very suited to the growth of paddy rice plants. From the nature of nitrogenous sources, it may be expected that the hydrogen ion concentration will become greater and greater after the absorption of culture plants. Therefore those solutions containing the largest amount of phosphate

would be the fittest medium for the growth of paddy rice, if phosphate had reacted only as a buffer.

TABLE XX

Oryza sativa: 6 plants in each culture containing 400 cc. of nutrient solution. Aug. 20–Sept. 2, 1925. Temp. 20°C.

Series No.	Dry weight (gm)		pH		Degree of whitening in leaf-blade
	shoot	root	initial	final	
1	0.1613	0.0692	4.3	3.0	+
2	0.1340	0.0629	„	3.3	+
3	0.1180	0.0657	„	3.4	++
4	0.0989	0.0618	„	3.5	++
5	0.1004	0.0681	„	„	++
6	0.0988	0.0681	„	3.6	+++
7	0.0789	0.0647	„	3.7	++++
8	0.1171	0.0667	„	3.8	++

Just as in the foregoing experiment, the development of root system was very excellent, though the growth of shoots was by no means good. The whitening of leaf-tips occurred in every culture, especially in series 7. Plant growth in series 1 and 2 was the best of all. At the end of the experiment, the plants in series 7 wilted and no green color could be seen in the shoot of the plants grown in series 6, 5 and 4. As a whole, the degree of injuries is proportional to the amount of phosphate in the solution. The dry weight of the shoots grown in the solutions without $\text{NH}_4\text{H}_2\text{PO}_4$ was greater than that in all other solutions with $\text{NH}_4\text{H}_2\text{PO}_4$ as nitrogenous source. Among the solutions containing $\text{NH}_4\text{H}_2\text{PO}_4$, the dry weight is inversely proportional to the amount of phosphate. As the dry weight of root was similar in all series, phosphates have no ill effect on the root development.

V. The Antagonistic Action of Calcium Ion against Hydrogen Ion

The purpose of the following experiments was to study the influence of calcium ion upon the growth of seedlings. PRIANISCHNIKOW ('24) found that the injury of ammonium sulphate upon plant growth can be reduced or even avoided by adding a suitable amount of CaCO_3 to the solution. In this case, the action of CaCO_3 consists in neutralizing the

increasing acidity which results from unequal absorption of ions. Recently, however, the antagonistic action of Ca-ion against H-ion has been ascertained by many authors (KAHHO, '24; LUNDEGÅRDH, '24; PRIANSCHNIKOW, '23; BRENNER, '20; SAKAMURA, '22 and '24.). In the present experiments M/10 solution of CaCl_2 was used instead of CaCO_3 in order to avoid the neutralisation by the latter.

The stock solutions used in the experiments with wheat and lupines were as follows:

Stock solution

I) with $(\text{NH}_4)_2\text{SO}_4$ as N-source;

$(\text{NH}_4)_2\text{SO}_4$	8.1 gm.
KH_2PO_4	2.5 "
$\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$	2.5 "
dist. water	500 cc.

II) with $\text{NH}_4\text{H}_2\text{PO}_4$ as N-source;

$\text{NH}_4\text{H}_2\text{PO}_4$	14.0 gm.
KH_2PO_4	2.5 "
$\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$	2.5 "
dist. water	500 cc.

EXP. 21. *Triticum vulgare*, "Martins Amber."

The composition of the nutrient solutions was as follows:

Series No.	Stock sol. I (cc)	CaCl_2 (cc)	Sum (cc)	pH
1	50	5	1000	4.9
2	"	10	"	"
3	"	15	"	"
4	"	20	"	"
5	"	25	"	"
6	"	30	"	"
7	"	35	"	"

The nutrient solutions were renewed on the 21st of September.

As will be seen from Table XXI, the initial pH of the nutrient solution was too acidic for the best growth of wheat and this acidity became greater and greater as the plants grew up. Nevertheless, the plant growth was tolerably good in every culture except those containing the largest and the least amount of calcium chloride. The maximum growth took place in the solutions where 20 cc. of CaCl_2 (M/10) was added to every litre of nutrient solution.

TABLE XXI

Triticum vulgare: 5 plants in each culture containing 270 cc. of nutrient solution. Sept. 7-28, 1925. Temp. 15-24°C.

Series No.	Dry weight (gm)		pH		
	shoot	root	initial	Sept. 21	final
1	0.1804	0.0493	4.9	3.0	4.1
2	0.1781	0.0492	"	3.1	4.2
3	0.1931	0.0559	"	3.0	3.8
4	0.2104	0.0583	"	"	"
5	0.1907	0.0584	"	3.1	3.7
6	0.2003	0.0566	"	3.0	3.8
7	0.1653	0.0475	"	"	4.0

Exp. 22. *Triticum vulgare*.

As the culture vessels Jena glass beakers were used. The concentration of the nutrient solution was as follows:

Series No.	Stock sol. II (cc)	CaCl ₂ (cc)	Sum (cc)	pH
1	25	5	1000	5.2
2	"	10	"	"
3	"	15	"	"
4	"	20	"	"
5	"	25	"	"
6	"	30	"	"

The nutrient solutions were renewed once a week.

TABLE XXII

Triticum vulgare: 6 plants in each culture containing 300 cc. of nutrient solution. Sept. 7-Oct. 7, 1925. Temp. 15°-24°C.

Series No.	Dry weight (gm)		pH					
	shoot	root	initial	Sept. 12	Sept. 18	Sept. 24	Oct. 1	final
1	0.3205	0.0730	5.2	3.3	3.7	3.4	3.3	3.6
2	0.3883	0.0728	"	"	3.5	3.2	3.1	3.5
3	0.4040	0.0742	"	"	"	"	"	3.3
4	0.4005	0.0760	"	"	"	3.3	3.0	"
5	0.4117	0.0818	"	3.4	"	3.1	3.2	3.2
6	0.4007	0.0803	"	"	"	"	3.1	3.4

The plant growth was excellent, especially the development of the root system. Though the acidity of the nutrient solutions was changed a great deal before every renewal of the culture media, the injurious feature due to high acidity did not appear on the leaves of any plants in this case. The plants in series 5 showed the best growth.

EXP. 23. *Lupinus luteus*.

This experiment was carried out in a greenhouse. Tall beakers of Jena glass were used as culture vessels. The composition of the nutrient solutions was as follows:

Series No.	Stock sol. II (cc)	CaCl ₂ (cc)	Sum (cc)	pH
1	20	0	400	5.6
2	"	5	"	"
3	"	10	"	"
4	"	15	"	"
5	"	20	"	"
6	"	25	"	"

TABLE XXIII

Lupinus luteus: 3 plants were grown in each culture containing 400 cc. of nutrient solution. Oct. 3-26, 1925. Temp. 20°C.

Series No.	Dry weight (cc)		pH	
	shoot	root	initial	final
1	0.3603	0.0943	5.6	3.4
2	0.4107	0.1023	"	3.5
3	0.4158	0.1187	"	"
4	0.4243	0.1028	"	3.7
5	0.3942	0.0883	"	3.8
6	0.3577	0.0867	"	3.7

The plants growth in culture series 2, 3 and 4 were almost equally good.

EXP. 24. *Oryza sativa*, "Hung King Chen."

Nitrogenous sources used in this experiments are as follows:

Series No.	N-sources
1.....	NH_4NO_3
2 }.....	$(\text{NH}_4)_2\text{SO}_4$
3 }	
4 }.....	$\text{NH}_4\text{H}_2\text{PO}_4$
5 }	

The nutrient solutions had the following composition.

Series No.	Stock sol. A (cc)	N-source (cc)	CaCl_2 (cc)	Sum (cc)	pH
1	50	50	0	1000	5.1
2	"	"	0	"	"
3	"	"	20	"	4.9
4	"	"	0	"	5.6
5	"	"	20	"	5.6

Harvesting was practised once a week. At the times of harvesting, the pH-value of the nutrient solutions was determined and the dry weight of the culture plants was estimated. NESSLER's test was also conducted to see whether the amount of ammonia in the solution was exhausted or not. A growth curve (Fig. 5) was drawn based on the data thus obtained. The values shown in Table XXIV were the average of the duplicates (s. p. 199).

As a result of bad weather the plant growth of this experiment was very poor. The plants in the NH_4NO_3 and $(\text{NH}_4)_2\text{SO}_4$ -cultures appeared comparatively good, but in the $\text{NH}_4\text{H}_2\text{PO}_4$ -culture with or without calcium the whitening of leaf-tips occurred in every plant. The above results show clearly the beneficial action of calcium; the plants grew better in the solutions containing Ca than those in the Ca-free cultures.

The results of foregoing experiments show clearly the beneficial influence of calcium ions. If suitable amount of calcium chloride was added to the solutions whose reaction becomes more and more acidic, seedlings can grow in them quite well. Thus with the presence of Ca-ion wheat seedlings grew tolerably good in such solutions whose reaction became as acidic as pH 3.0 or 4.0. Even in the case of paddy rice plants, which prefer higher acidity to neutrality or alkalinity, the addition of calcium chloride produced better results. The best concentration of CaCl_2 for the maximum growth is about M/500, the concentration greater

than this seemed to be unsuitable for the growth of seedlings. Superabundance of calcium in culture solution, therefore, suppresses growth.

TABLE XXIV

Oryza sativa: 6 plants in each porcelain beaker containing 400 cc. of nutrient solution. Oct. 7—Nov. 10, 1925. Temp. 15°C.

Series No.	Culture duration	Dry weight (gm)		Length (cm)		pH		NESSLER'S reaction
		shoot	root	shoot	root	initial	final	
1	7 days	0.0520	0.0882	11	7	5.1	3.5	+
"	14 "	0.0732	0.0670	13	8	"	3.3	+
"	21 "	0.0922	0.0700	14	8	"	3.4	+
"	28 "	0.1270	0.0750	16	8	"	"	+
"	35 "	0.1150	0.0695	16	8	"	"	+
2	7 "	0.0492	0.0830	11	7	5.1	3.4	+
"	14 "	0.0742	0.0722	13	8	"	3.2	+
"	21 "	0.0925	0.0692	15	8	"	3.0	+
"	28 "	0.0895	0.0660	13	8	"	3.3	+
"	35 "	0.1078	0.0705	15	8	"	3.2	+
3	7 days	0.0517	0.0878	11	7	4.9	3.3	+
"	14 "	0.0632	0.0750	13	8	"	"	+
"	21 "	0.0750	0.0705	12	9	"	3.2	+
"	28 "	0.1055	0.0690	14	8	"	3.1	+
"	35 "	0.1191	0.0705	15	8	"	3.2	+
4	7 "	0.0468	0.0960	10	6	5.6	5.0	+
"	14 "	0.0650	0.0795	12	9	"	4.3	+
"	21 "	0.0650	0.0720	13	9	"	4.4	+
"	28 "	0.0698	0.0678	13	8	"	4.9	+
"	35 "	0.0762	0.0655	13	9	"	4.7	+
5	7 "	0.0522	0.0900	12	7	5.6	4.7	+
"	14 "	0.0628	0.0745	12	9	"	4.3	+
"	21 "	0.0608	0.0690	12	9	"	4.6	+
"	28 "	0.0748	0.0758	12	9	"	4.8	+
"	35 "	0.0875	0.0690	13	9	"	4.9	+

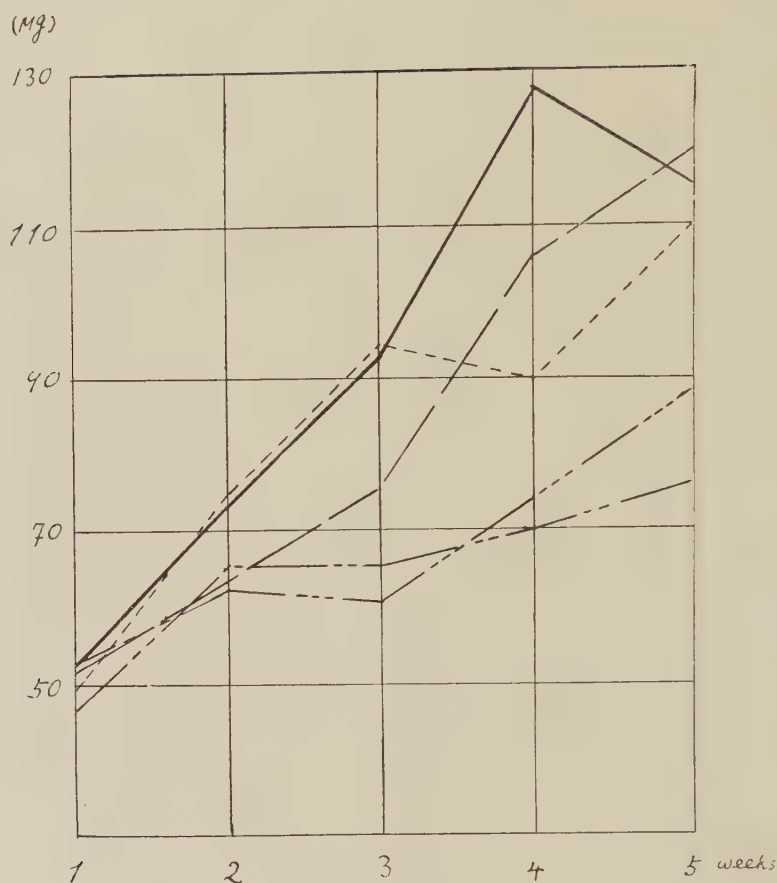


Fig. 5. Growth curves of paddy rice plants :

————— Series 1, Series 2, - - - Series 3,
 - - - - - „ 4, - - - - - „ 5.

Summary

1. Water cultures were carried out with a number of cultivated plants in modified KNOP solutions. Instead of $\text{Ca}(\text{NO}_3)_2$, NaNO_3 and inorganic ammonium salts were used as sources of nitrogen. Stress was laid on the observation of reaction change of the culture solution caused by growing seedlings and on its effect upon growth.

2. In contact with the root system of the culture plants the reaction of the solutions containing NH_4NO_3 , NH_4Cl , and $(\text{NH}_4)_2\text{SO}_4$ respectively

becomes considerably acidic; the degree of reaction change is proportional to the dissociation degree of these acids.

3. The hydrogen ion concentration of the solution containing $(\text{NH}_4)_2\text{HPO}_4$ changes but slightly; that of the solution with NH_4HCO_3 as nitrogenous source also remains constant or inclines to the alkaline side due to the escape of CO_2 in the case of bad growth of the culture plants.

4. The control solution containing NaNO_3 always becomes less acidic except in the case of buckwheat, horsebean and lupines where a slightly increase of hydrogen ion concentration is recognized.

5. The cause of such change of reaction is ascribed to the unequal absorption of ions by plants.

6. The increase of hydrogen ion concentration in the solutions containing NH_4NO_3 , NH_4Cl and $(\text{NH}_4)_2\text{SO}_4$ generally produces poor growth of culture plants with the exception of paddy rice and buckwheat. The great alkaline reaction of the solution with NH_4HCO_3 as nitrogenous source always gives ill effect to the seedlings (except wheat and corn). On the other hand, the slow and slight change of hydrogen ion concentration in the control solution and $(\text{NH}_4)_2\text{HPO}_4$ -culture causes favorable growth of plants.

7. Special character of plants in producing the reaction change and in relation to the effect of this change is pointed out.

8. A combination of two ammonium salts such as NH_4Cl and NH_4HCO_3 used as nitrogenous source instead of single one, gives better results; the fluctuation of growth feature in parallel to the reaction change is noted, the important relation of the buffer action of the nutrient solution to plant growth is discussed.

9. The inferiority of ammonium salts as the source of nitrogen for higher plants is ascribed to the increase of hydrogen ion of the culture solution containing it during the plant growth.

10. In the solutions with NH_4Cl or $(\text{NH}_4)_2\text{SO}_4$ as nitrogenous source, the increase of acidity was retarded to some extent by adding phosphates of sodium to the solution and this retardation produces good growth.

11. In the solutions of strong buffer capacity, the initial pH of the solution has very great influence upon the plant growth; if the initial pH is not suited to the growth, solutions of strong buffer action are injurious rather than beneficial for the culture plants.

12. Superabundance of phosphate in the culture solution has some special ill effect on the seedlings of paddy rice. Phosphates of ammonium, potassium and sodium produce the characteristic whitening of leaf tips.

13. The addition of calcium chloride to the solution generally produced good effect; the injury due to higher acidity may be lessened or avoided.

14. In this work, iron was added in the form of ferric chloride, or ferric or ferrous sulphate. No difference in value as iron source can be found in these salts when iron is added in trace.

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On Intersexualism in *Arisaema japonica* Bl.

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With Plates VII-VIII

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Introduction

Arisaema japonica has been deemed to be a dioecious plant. However, by continuous observation of one and the same plant for several years, it was found that the same plant regularly undergoes a peculiar process of sex transformation, provided the normal growing conditions remain undisturbed (MAEKAWA, 1924).

At the beginning of its life history, the young plant fails to display its sexual character as we see in any perennial herbs in which no flowers are borne in the first year of sowing. This immature stage continues two or more years in *Arisaema japonica*. From the view point of sexuality we may call this scapeless stage the asexual stage. Then the asexual condition is followed in a very regular way by the male condition, and then after remaining one or two years in that condition the plant transforms its sexual condition into the female. This ultimate condition continues for years and does not change as long as the plant grows healthily. However, natural check in growth may come when the corm reaches its zenith. In very large corm there are formed some fissures upon the surface, probably by the strength of too much reserve material formed by the large assimilation organs. These fissures or wounds are very fatal to the corm, owing to the defenceless exposure of storage tissues to the dangerous soil bacteria and animals. The corms are very easily attacked by them and their decay often follows. In some cases the mother corm disappears entirely, leaving some daughter cormlets behind it.

This brief description of life history of the plant shows very clearly that its sexual expression is regularly transformed from asexual condition into the male state and then into the female state where it continues as long as the vegetative organs grow undisturbed.

The writer examined whether some physiological disturbances of the vegetative organs can break this process or not. Some individuals which were seriously wounded, reversed their sex from male to asexual and from female to male. But in the course of one or two years care under normal conditions they recovered, without exception, their normal process of sex transformation. This shows us that the manipulation is not able to give rise to more than a temporary modification of the process of sex transformation. In another instance, a group of these plants were observed under cultivation in a sand bed for more than two years. However, the transformations shown by them were either a retardation of the process or a temporary reversion of the sex condition, which soon recovered their normal process after cultivation in a good soil. This experiment proved us that the process is an inherent character of the plant species under question. The writer calls this phenomenon that of sex transition.

These special phenomena in sex transformation shows us at the same time that the process proceeds forwards as the plant grows larger and *vice versa*. The writer found in this connection that there exist some relations between the weight of the corm and its sexual condition, namely, the light corms (weighing less than 4 gr.) are asexual, the weighty corms (weighing above 21 gr.) express the female sex, and the male corms lie between these two extremities in general. However, it can not be said that the weight of the corm bears a direct relation to the cause of sex determination.

The plant consists of a corm, two foliage leaves, and a scape at the axil of the upper foliage leaf. A flower bud of the next year is formed at the very axil of the lower foliage leaf in the present vegetative season. The sex of this bud is already determined in the early fall. Therefore we may say that the determination of sex seems to be performed in a very short period from the latter half of July to August which, significantly, coincides with the season of very active assimilation. The author thinks that the quantity of formative assimilation products transferred at the place of flower formation determines its sex condition. If the quantity is too small to meet the needs of the flower formation, the corm remains asexual the next year. If the supply of the assimilation products is sufficient, the sex of a corm may be male or female. The male plant may change to female condition if it is supplied with a sufficient quantity of assimilation products; but if the supply comes short to meet the female expression it remains in the male condition. The

relation between the weight of corm and sexual expression may be easily stated to the effect that the larger the corm, the larger the assimilation organ and hence a larger quantity of assimilation products.

This statement coincides very well with our experiments in which we can easily control the sex by means of physiological disturbances, namely, leaf cutting, corm cutting, darkroom cultivation, and so on. Judging from the observations and experiments mentioned above, the author puts forth his opinion that the tendencies for maleness and for femaleness must coexist in the diploid cells, and the quantity of formative assimilation products act as a help for letting manifest one sex or another.

Recently the question of sex determination has made a very noteworthy progress. Some authors have offered valuable contributions on the most difficult and interesting problem, namely, intersexualism in the higher phanerogamous plants. The present author wishes to describe some interesting cases of intersexualism observed in *Arisaema japonica*, together with its explanation.

Description of the Intersexual Spadix

The appearance of an intersexual spadix is not very frequent. Ten spadices which we are going to describe are the whole number collected in our experimental plots where 300 to 400 corms are cultivated every year.

Like a normal spadix the main portion of an intersexual one is conical-shaped, and upon its surface, we see numerous unisexual flowers densely arranged in an apparent phyllotaxical row. However, by closely tracing the parastichies we find some considerable disturbances existing among them. Some parastichies starting from the basal flowers stop short before they reach the end, because the size of all the flowers is almost equal, while the circumference of a spadix is greater at the lower than at the terminal portion. However, this disorder can be rearranged again to an ideal diagram by some replenishments of wanting flowers. The writer prepared thus some diagrams concerning flower arrangements in the intersexual spadix, aiming at representing them as correctly as possible.

It must be noticed here that our phyllotaxical diagram does not bear the same meaning as that in which the scale arrangement of a coniferous cone is represented. The anatomical consideration in the formation of a young spadix is quite different in our case. In the

growing point of ordinary vegetative shoots, we see the *Anlage* of young leaves appear one by one in acropetal succession so that their order may be easily traced along a spiral line around the axil. In this plant the case is quite otherwise for the reason that firstly, the young spadix is formed before young flowers are seen upon it, and secondly, the flowers do not appear in successive manner but a number of primordial flowers are produced simultaneously upon the surface. For these reasons our diagrams showing the arrangement of flowers may be regarded merely as apparently phyllotaxical ones.

Corm No. 1 (Pl. VII, Fig. 1 ; Pl. VIII, Fig. 1):

64 male flowers (43.2 %) and 86 female flowers are present in this material. Male and female flowers are arranged in different groups, female flowers at the upper portion and male flowers at the lower, without showing any confusion among the parastichies at the boundary.

Corm No. 2 (Pl. VII, Fig. 2 ; Pl. VIII, Fig. 2):

One male flower (0.6 %), 165 normal, and 4 abortive female flowers are present in this material. These abortive flowers and the male flower are found at the termination of their own parastichies. The abortive females (Pl. VII, Fig. a and b) are small and their ovary walls are four-lobed. Each lobe presents a stigmatic structure at its tip. This abnormal construction seems very interesting as compared with the abnormal male flowers described later, because they suggest that the lobes are homologous to the filament of the staminate flowers while the ovules containing egg cells are homologous to the pollen-sacs containing pollen grains. This idea leads us to suppose that only a slight stimulation given to the flower-*Anlage* will be enough to determine its tendency for a male or for a female expression.

No. 3 (Pl. VII, Fig. 3 ; Pl. VIII, Fig. 3):

2 normal male (0.1 %) and 195 female flowers are present in this material. These male flowers are found at the termination of their own parastichies.

No. 4 (Pl. VII, Fig. 4 ; Pl. VIII, Fig. 4):

38 male flowers (30.6 %), 85 female flowers and one hermaphrodite flower are present in this material. Male flowers are grouped at the upper portion of the spadix. The boundary between the male and female group is somewhat confused, though, with some careful rearrangement the confusion may disappear. The hermaphrodite flower is found at the upper boundary of the female group. This flower has a normal sessile pollen-sac upon a small process at the shoulder of the ovary wall

as can be seen in the figure (Pl. VII, Fig. c). The pollen-sac is yellow and contains normal pollen-grains.

No. 5 (Pl. VII, Fig. 5 ; Pl. VIII, Fig. 5):

73 male flowers (58.4 %) and 52 female flowers are present in this material. The male and female groups are distinctly separated from each other to the right and left. Some abortive male flowers are found among the male group. They consist of slender filaments bearing one or two pollen-sacs or they are represented by curved slender filaments only (Pl. VII, Fig. d and e).

No. 6 (Pl. VII, Fig. 6 ; Pl. VIII, Fig. 6):

45 male flowers (32.1 %) and 95 female flowers are present in this material. Male flowers are grouped at the lower, and the female flowers at the upper portion.

No. 7 (Pl. VII, Fig. 7 ; Pl. VIII, Fig. 7):

6 normal male (4.1 %) and 141 female flowers are present in this material. These male flowers are found at the upper termination of their own parastichies.

No. 8 (Pl. VII, Fig. 8 ; Pl. VIII, Fig. 8):

One normal and 6 abortive male flowers (3.7 %) and 181 normal female flowers are present in this material. These male flowers are situated at the uppermost portion of the spadix. The abnormal male flowers consist of four stamens more or less connated at the lower portion unlike a normal staminoid flower in which the filaments are entirely connated into a solid column bearing pollen sacs at the end of small branches (Pl. VII, Fig. f and g).

No. 9 (Pl. VII, Fig. 9 ; Pl. VIII, Fig. 9):

36 male flowers (26.3 %), 100 female flowers and one hermaphrodite flower are present in this material. The male flowers are distributed in two parts, upper and lower, the female being observed between them. Some abnormal male flowers, shaped like the abnormal males described in No. 5 material, are found among the upper male group. The hermaphrodite flower is found at the upper boundary of the female group. This flower seems to have resulted through the connation of a slender male flower and a normal female flower as seen in Fig. h in Pl. VII.

No. 10 (Pl. VIII, Fig. 10):

7 male flowers (4.5 %) and 147 female flowers are present in this material. The males are found in the upper margin of the spadix, each terminating its own parastichy. Male and female flowers are normal.

On Some Characteristics of the Intersexual Spadix

1) *On the Intergradation of Sexual Expressions in Flower Numbers and in Flower Construction*

The percentages of male flowers contained in the observed intersexual spadices range from 0.1 % to 58.4 % as shown in the following table.

Table showing the percentages of male flowers in the intersexual spadices

No.	Male fl.	Female fl.	Hermaphrodite fl.	Total	%
1	64	86	....	148	43.2 (+)
2	1	169	....	170	0.6 (—)
3	2	195	....	197	0.1 (+)
4	38	85	1	124	30.6 (+)
5	73	52	....	125	58.4 ()
6	45	95	....	140	32.1 (+)
7	6	141	....	147	4.1 (—)
8	7	181	....	188	3.7 (+)
9	36	100	1	137	26.3 (—)
10	7	147	....	154	4.5 (+)

As seen in the above table, the grade of intersexuality is various, so that some spadix in which almost all the flowers are male may well be expected.

In the floral construction of abortive males we find also some intergradation. In the case of slightest abortion, the number of pollen-sacs is decreased to less than three, while, in the most extreme case, the staminoid flower is reduced to a mere slender filament without pollen-sac. Or in some aborted male flowers, the filaments are connated side by side to make a flat band bearing pollen-sacs upon each of them.

In the female flowers this deformation, represented in our materials, are shown in two ways. In one case the ovary walls are more or less broken so that small ovules can be seen in them directly from outside. In another case the upper portion of the ovary is four-lobed so that an intermediate stage between pistillate and staminoid flowers may be imagined.

2) *On the Arrangement of Male and Female Flowers*

The state of arrangement of flowers is another point to be noticed. As regards the author's materials, it is a very distinct feature that different kinds of flowers do not intermingle with each other, but they flock together, male to male and female to female, as may be seen in the diagrams. This fact coincides very well with the fact that a group of young flowers are formed after the first group of flowers has been produced.

Therefore it is quite natural to observe that an influence, internal or external, playing upon the determination of sex is limited only to that group of flowers just under formation. If the same influence dominates during the period of scape formation, the sex of the spadix must be of one kind (normal spadix), while, if the condition changes then for a while, the sex of a group of flowers, which have been just under the formation at that time, must also change correspondingly (intersexual).

3) *Intersexual Corms and their Future Sex Expression*

We have already mentioned that in *Arisaema japonica* there prevails a normal transition of sex, while sometimes there take place the reversal transformations caused by physiological disturbances in the corm or in shoot system or in both organs. It may therefore be worth while to examine the sexual expression in these materials in the past and also in the following years.

Without any single exception the author's intersexual plants transformed into the female in the succeeding years of observation and, in general, entered into the normal process of sex transition. However, it is very interesting to notice that a majority of the intersexual materials have been derived from those corms which have been wounded in their vegetative organs.

In our former investigation, the writer intended to control the sexual expression in his material and for that purpose he either applied some mechanical wounds at the vegetative organs, for instance, corm- and leaf-cutting, or made the darkroom cultivation.

In our intersexual materials, 5 spadices out of ten were grown from corms which were just recovering into the female sex from their reversed male condition caused by the manipulation as shown in the following table.

Table showing the sex records of the intersexual spadices,
with their corm weights in grams.

No.	1918	1919	1920	1921	1922	1923
1	♀ (53.0)	*♀ (19.0)	♂ (23.0)	♂ (23.0)	↑♀ (—)	♀ (—)
2	♀ (55.0)	**♀ (23.0)	(—)	(—)	↑♀ (—)	♀ (—)
3	♀ (67.0)	♀ (156.0)	♀ (133.0)	♀ (152.0)	♀ (—)	↑♀ (—)
4	♂ (24.0)	♂ (23.0)	♂ (44.0)	♀ (46.0)	↑♀ (—)	♀ (—)
5	♀ (121.0)	***♀ (118.0)	***♀ (81.0)	***♀ (30.5)	↑♀ (—)	♀ (—)
6	♀ (127.0)	↑♀ (74.0)	↑♀ (30.5)	♂ (39.0)	↑♀ (—)	♀ (—)
7	(2.5-4.0)	♂ (—)	♂ (13.0)	♂ (31.0)	↑♀ (—)	♀ (—)
8	♀ (33.0)	♀ (80.0)	♀ (141.0)	♀ (122.0)	↑♀ (—)	♀ (—)
9	♀ (129.0)	↑♀ (172.0)	↑♀ (143.0)	↑♀ (44.0)	↑♀ (—)	♀ (—)
10	♀ (43.0)	♀ (103.0)	♀ (120.0)	♀ (95.0)	(—)	↑♀ (—)

* Reduced to 19 gr by corm cutting

** Reduced to 23 gr by corm cutting

*** Applied leaf blade cutting in 1919, 1920 and in 1921

↑ Applied leaf blade cutting in 1919 and in 1920

↑↑ Applied leaf blade cutting in 1919, 1920, and in 1920

The data observed in the intersexual spadices mentioned in the above paragraphs may be summarized as follows: namely, 1) there is a numerical gradation of male and female flowers, 2) male and female flowers form their respective groups, never intermingled with each other 3) the intersexual condition is not a permanent condition. They transformed their sex, without exception, from the male into the female in the succeeding years if the vegetative conditions are good, 4) it may be noticeable that the intersexual specimens are rather frequent in the plants which were wounded in the former years.

Abnormal Spadix and Intersexual Spadix

It is known that some abnormal specimens are sometimes met with in this plant (O. PENZIG, 1922). SCHAFFNER (1922) described some dichotomous twins of monosporangiate spadix in *Arisaema* and one monoecious example having a zone of carpellate flowers below, covering about three fifths of the spadix, and having a staminate zone above. These abnormal spadices may well be supposed to have been produced by some marked mechanical disturbances at the place of organ formation.

While considering the cause of the intersexual spadix, one might suppose that some mechanical disturbance (not physiological disturbance which we have supposed to be the real cause) at the *Anlage*, or some disturbance in flower arrangement caused by it would account for it. Therefore it is very important to examine whether there are some relations between the abnormal and intersexual spadices.

With this point in view the writer examined the many abnormal specimens in hand which were collected during experiments, and found that there was no intersexual spadix among the abnormal specimens. Therefore it may safely be stated that even considerable mechanical disorders bear no direct relation to the determination of the sex of flowers, and that only the quantitative relations of assimilation products can control the sex of young flowers.

The reason why in our abnormal materials there could be found no intersexual spadix is that there had been an uniform supply of plastic substances although a certain mechanical disorder had affected each rudimentary spadix. If we would find some monoecious spadix among the abnormal plants, it could well be accounted for by the explanation that there had been two prevalent influences during their formation, namely, an uneven supply of plastic substances and some mechanical disorders affecting it.

The following descriptions refer to abnormal spadices examined by me.

A. (Pl. VII, Fig. 10):

This female spadix presents a denuded line at the right side. The section of the main body of the spadix is semicircular instead of being round, and terminates with a flattened appendage which is bipartite at its tip. This disfiguration may have been induced by a check of growth against the spadix part caused by a wound at the *Anlage*. The sex record of this corm is as follows: normal male (1918-1920), monoecious (1921), abnormal female described in the above (1922), normal female (1923).

B. (Pl. VII, Fig. 11):

This abnormal spadix is divided into two round parts, each of which bears normal male flowers. Perhaps this abnormality may have been induced by some mechanical wounds at the *Anlage*, because no traces of twin growth are found throughout the shoot system. The sex of this individual was female in the following year.

C. (Pl. VII, Fig. 12):

The primary scape produced the side scapes at the basal part, one of which was very slender and smooth, bearing no flowers upon it. The

corm in the next year was female.

D. and E. (Pl. VII, Fig. 13 and 14):

Specimen D is a female spadix and specimen E is male. They are mentioned as abnormal spadices, as they have double spathes around them. Both of them were female in the next year.

F. Pl. VII, Fig. 15:

The spadix is elliptical bearing a flat appendage at the tip. This abnormal specimen may perhaps have been produced by close union of two young scapes because we notice a longitudinal groove along the scape.

If it is granted that some mechanical motives control the sex of the flowers at the time of flower formation these abnormal spadices might doubtless have turned into intersexual spadices, because the mechanical disturbances may have been very considerable when they were formed.

The writer thinks that the mechanical motives dominating at the time of flower formation do not influence the sex determination of flowers in a spadix.

Discussion

The writer has stated that the process of sex transition observed in *Arisaema japonica* may be considered as an inherent character peculiar to the said plant. The analysis of this property in the light of genetics, however, seems to the author to be very difficult at present. He has not found and probably can not find any "genetical mutant" in this plant, as SHULL (1910) and EMERSON (1924) found in his *Lychnis dioica* or *Zea Mays* respectively. It is still unknown in our plant, whether the sex is determined by a pair of factors or a great many pairs.

The writer thinks that the idea suggested by C. CORRENS (1920) on the sex nature of gametes in *Funaria hygrometrica* and afterwards mentioned by HARTMANN (1923), "Jedes sexuelle differenzierte Individuum (♂ wie ♀) sowie differenzierte Anlage enthält zugleich die vollständigen Anlagen zur Erzeugung des entgegengesetzten Geschlechts" is very probable in our plant. It is supposed, that perhaps the male and female tendencies coexist in a quite non differentiated state in the somatic cells as well as in the gametic cells of our plant. The writer has stated previously an idea that the phenotypical representations of sex in this plant are thought to be determined by the quantitative relation of plastic assimilation products during flower formation. On his study in *Lychnis Roemerii*, C. CORRENS (1925) has stated that the distribution of

female flowers in \pm male individuals is related to the distribution of nutriment. The writer thinks his intersexual case is quite similar to that of CORRENS. Sometimes for some reason a change of assimilation products may happen during the formation of the young spadix. The writer thinks this modification to be the cause of the intersexual spadix, and nothing else, e.g. mechanical motives, to influence the determination of sex in this plant. The evidence of unisexual and abnormal spadix proves this belief. This direct influence of plastic substances, however, does not mean the permanent alternation of either male or female tendency to a male or to a female nature. The writer means that the male sex results when the quantity of assimilation products is sufficient enough for male tendency but insufficient for the female. The outer conditions which may influence the production of assimilation products, such as corm cutting or darkroom cultivation or careful cultivation in a rich soil and so on, may not always answer our expectation when the resulting quantity of assimilation products reaches above or falls under the critical limit of quantity which corresponds to the manifestation of the male or female sex. In this sense we agree with the statement of MCPHEE (1924) that the outer condition affects the sexual expression, because the outer condition has only an indirect influence upon it.

Summary

1) The appearance of an intersexual spadix is not very frequent. Ten spadices of this kind are described with their diagrams showing the arrangement of male and female flowers.

2) In intersexual spadices we find some intergradations in the proportion of male and female flowers, and also in their constructions.

3) The state of arrangement of flowers on a spadix is very distinct. They do not intermingle with each other, but they flock together male to male and female to female.

4) All our intersexual plants transformed their sex into the female state in the succeeding years.

5) It is noticeable that the intersexual specimens are rather frequent in the plants which were wounded in the former years.

6) 6 abnormal spadices are studied. They are all pure concerning their sexual states. The author thinks that no mechanical motives bear any relations to the sex determination of flowers.

7) It is stated that the phenotypical representations of sex in this plant are determined by the quantitative relation of plastic assimilation

products during flower formation. If the same quantity of plastic materials is supplied unchanged during the whole time of flower formation, the sex expression of all the flowers upon a spadix may be of one kind (normal spadix), while if the quantity of the substances is changed for a while by an internal or external condition, the sex of a group of flowers, which have been under formation at that time, is changed into another sex expression (intersexual spadix).

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Explanation of Figures.

PLATE VII

Fig. 1-9. Intersexual spadices.

Fig. 10-15. Abnormal spadices. Fig. 10, Fig. 13 and Fig. 15 are females. Fig. 11, Fig. 12 and Fig. 14 are males.

Fig. a and Fig. b. Abortive female flowers. Fig. a $\times 10$. Fig. b $\times 8$.

Fig. c and Fig. h. Hermaphrodite flowers. Fig. c $\times 3$. Fig. h $\times 7$.

Fig. d. Abortive male flower. $\times 7$.

Fig. e. Abortive male flower. $\times 8$.

Fig. f. Abortive male flower. $\times 6$.

(All figures somewhat reduced in size for reproduction)

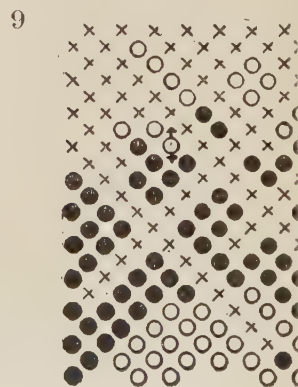
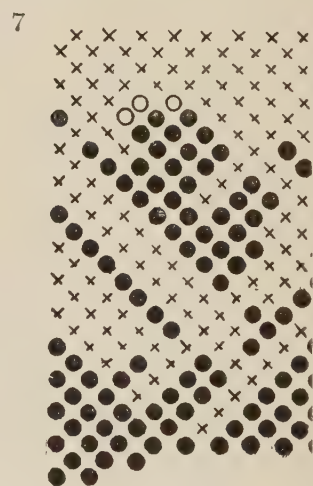
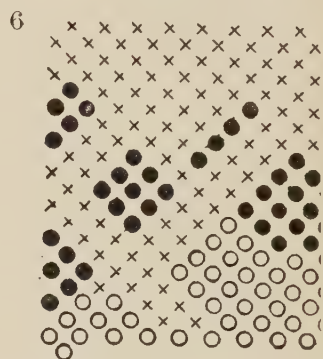
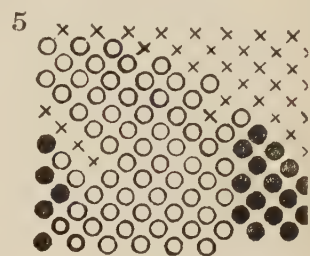
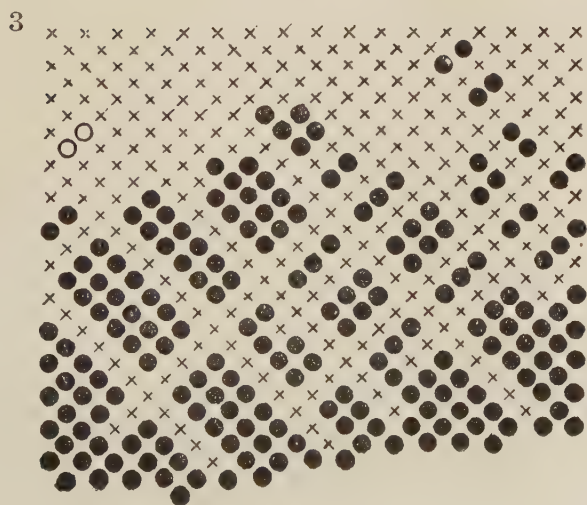
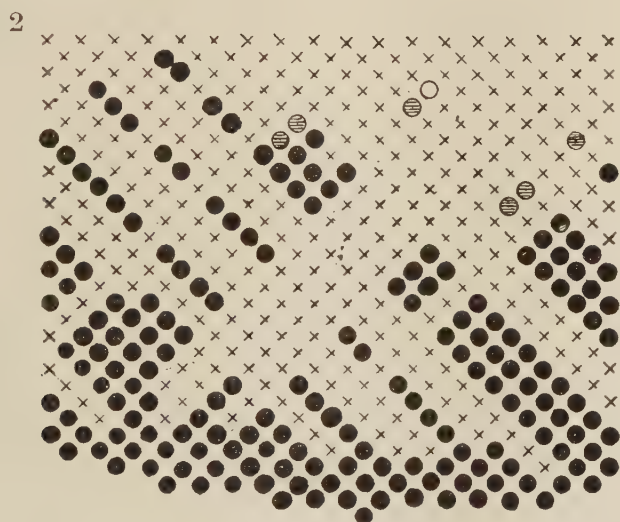
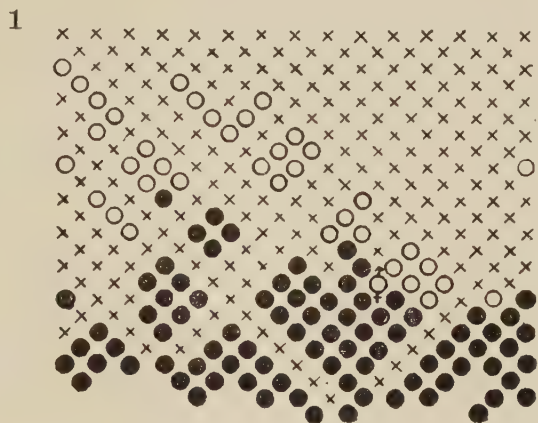
PLATE VIII

Explanation of signs. ● female flower. ○ male flower. ● abortive female flower.

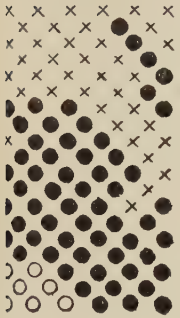
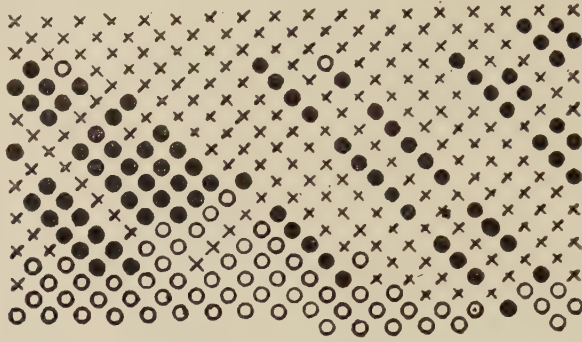
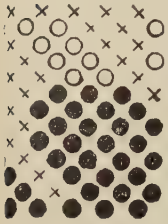
● abortive male flower. × absence of flower.

Fig. 1-10. Diagrams of male and female flower arrangements.

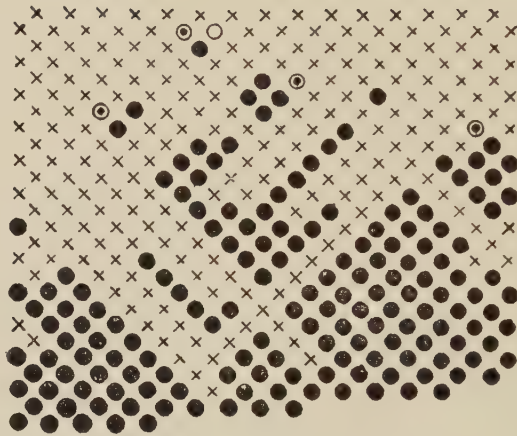




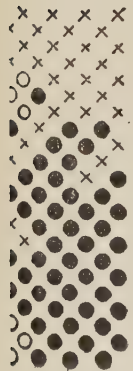
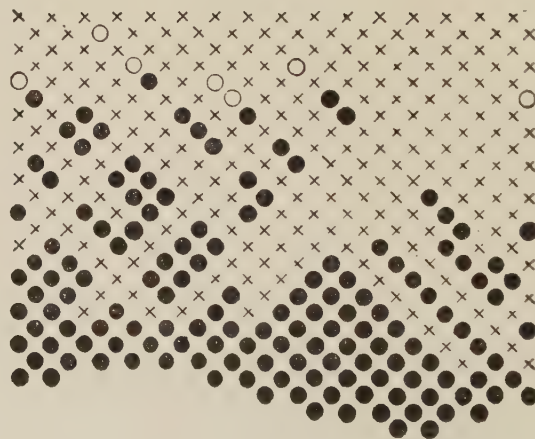
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A Cytological Study on Pollen Sterility in *Solanum tuberosum* L.

By ISAMU STOW

With Plate IX and 48 Textfigures

(Contribution from the Botanical Institute, Hokkaido Imperial University,
Sapporo. Received October 16, 1926)

Introduction

It is a well known fact, that there are various cases of sterility in several varieties of the potato plant. YOUNG (1923) and FUKUDA⁽¹⁾ who have tried to explain this phenomenon cytologically, consider the pollen abortion in consequence of abnormal meiotic division as its chief cause. Based on the observation of materials from forty potato varieties the latter author came to the conclusion that the degree of sterility keeps pace with that of the abnormality in the reduction division. YOUNG confirmed also that the unfertilized eggs are not able to develop parthenogenetically and degenerate sooner or later. Although both authors recognized the influence of external factors as one of the causes of the abnormal reduction division of the pollen mother cells, they have attached the chief importance rather to the nature of the plant itself.

On the other hand, the fact that such an abnormal reduction division is found generally in plants of other kinds cultivated for a long time, and that the degree of the deviation from the normal division is not always equal even in the same potato variety, led the writer to consider also the great rôle of the environmental conditions, which act upon the plant life either directly or indirectly.

According to the suggestion of Prof. SAKAMURA, the writer has undertaken the cytological researches on this problem, with special regard to the relation between the meiotic division of the pollen mother cells

(1) His work was done in this laboratory about six years ago, and has been left unpublished. The writer thinks, however, that it will be soon published, and he believes that his work will furnish much valuable information towards the present investigation.

and the external conditions⁽¹⁾. After a thorough investigation the writer came to an interesting conclusion that the temperature is the principal factor which influences the meiotic division of the pollen mother cells of the potato plant. This fact has been already shortly reported in the joint work of SAKAMURA and the writer (1926), though they treated there mainly other cytological subject which is certainly concerned with the present question. The results⁽²⁾ of the researches obtained in the past two years will be reported in the present paper, though the writer is yet engaged in further investigation in this direction.

Materials and Methods

The varieties of the potato plant used in the present work are as follows :

Gratiola*, Parnassia*. Pirola*, Marschal Hindenburg*, Deodara*, Tuno*, Belladonna** Pepo*, Snowflake, Green Mountain, American Wonder, Rural New Yorker, Michigan, Burbank's Seedling, Nemuro-Murasaki, Ekishirazu.

Among these varieties, those with an * which were imported in this country from Germany a few years ago came mostly under the present investigation. The materials were taken from the plants, which had been ascertained not to have had any contact with the mosaic disease either in previous years nor while the investigation was carried out⁽³⁾. The perianth was at first peeled off from young flower buds. The anthers from these buds were first treated with CARNOY's alcohol-chloroform-acetic acid solution for a few minutes, and then transferred to FLEMING's Bonn-solution for perfect fixation. Sections were cut 8-11 μ in thickness and stained with HEIDENHAIN's iron-alum haematoxylin. The iron-acetocarmine method⁽⁴⁾ of BELLING (1921) was also employed with very satisfactory result.

(1) As it is improbable from the work of FUKUDA and YOUNG, that the hybrid or parthenogenetic nature is the cause of the pollen sterility of this plant, the writer has kept away from the problems which have to do with such natures.

(2) The results have been preliminarily reported in the Proceedings of the Imperial Academy, Vol. 2 No. 8. (1926), 426-430.

(3) These healthy plant materials were delivered from The Hokkaido Agricultural Experimental Station, Sapporo-Kotoni. The writer expresses his appreciation for the kindness of the authorities there.

(4) Iron-alum substituted for ferric hydrate in BELLING's prescription was without any marked difference in the result. About 10 drops of a 2% solution of iron-alum were added to 100 cc. of an acetocarmine solution. The inner structure of chromosomes observed in iron-acetocarmine preparations has been omitted in drawing.

Normal Reduction Division of the Pollen Mother Cells

As the observation of the stages preceeding the diakinesis has no direct bearing upon the purpose of the present investigation, their description will be omitted here, and the writer will call the reader's attention to the work of FUKUDA, which will be soon published and where the course of the reduction division of the pollen mother cells of about forty varieties of this plant has been thoroughly studied.

According to FUKUDA who has counted repeatedly the chromosome number in many varieties the haploid is $24^{(1)}$ and the diploid 48, the results which widely differ from those reported by NĚMEC (1899), MARTINS MANO (1904) and YOUNG (1923) (18, 17 and 14-16⁽²⁾ respectively).

The chromosome number of Gratiola, Parnassia, Pirola, Marschal Hindenburg, Deodara, Tuno, Belladonna and Pepo, which were not used in the work of FUKUDA, was determined in the metaphase of the first division, by means of the iron-acetocarmine method. The haploid number is 24 in every case (fig. 1, 3). No difference of chromosomes in size and shape was recognizable among these eight varieties. The abnormal nuclear and cell division which occur in these different varieties, was observed a few times. The result of the observation of the reduction division following the diakinesis will be described here. This observation was carried out with Gratiola, Tuno, Parnassia and Belladonna.

Diakinesis. Although it occasionally happens, that some of the chromosomes do not form perfect gemini, such formation is usual here, as the observations of FUKUDA and of the writer indicate. It is very difficult to decide whether the homologous chromosomes attach to each other side by side or end to end. The latter mode, however, seems to be more probable, because the multipartite chromosome is found frequently in this plant (see below) and moreover KOJIMA (1925) ascertained the end-to-end union in another species of the same genus, *Solanum Melongena*.

Metaphase of the heterotypic division. The number of the bivalent chromosomes on the equatorial plate is counted as 24 (fig. 1). No remarkable difference in size and shape is found in one chromosome set. The homologous chromosomes gradually move to the opposite poles in a regular manner and then the nuclei enter the interkinesis (fig. 2).

(1) In an individual of White City and some F_1 -hybrids between certain varieties, FUKUDA reported that he found pollen mother cells with 48 chromosomes as the reduced number and that the latter plants produced the fertile pollen grains by the normal reduction division. He regarded this case as an exceptional one.

(2) Somatic number (YOUNG 1923, p. 329).

Homoeotypic division. In the metaphase the chromosomes in the haploid number are arranged regularly on the equatorial plate (fig. 3), and in the anaphase each of the daughter chromosomes move to the two poles in equal number. The cell wall formation in the tetrad division, which takes place after the appearance of the nuclear membrane, is accomplished rather by the centripetal thickening of the mother cell-membrane, which is found sometimes to occur (fig. 4). The tetrad-cells are of the same size and shape, and their morphological characters appear

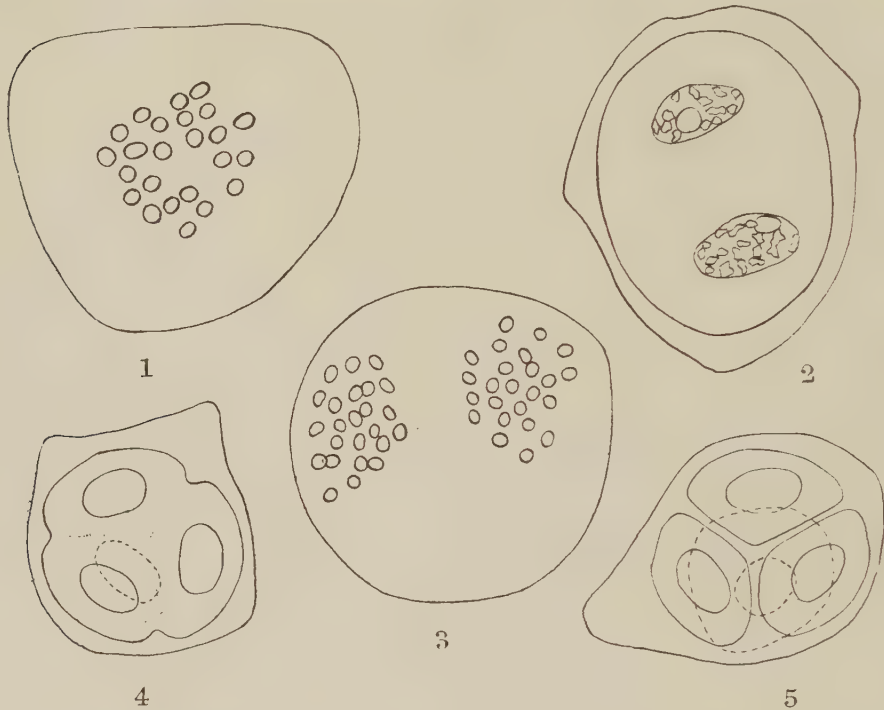


Fig. 1, 3-5: Iron-acetocarmine preparations of pollen mother cells.

Fig. 2: Material fixed with FLEMING's fluid, and stained with HEIDENHAIN's iron-alum haematoxylin.

Fig. 1. Tuno. A polar view of the heterotypic metaphase. Just 24 chromosomes. $\times 2120$.

Fig. 2. Belladonna. Interkinesis, neither trace of the constriction of the cytoplasm nor centripetal thickening of the mother cell-wall. $\times 1880$.

Fig. 3. Belladonna. Homeotypic metaphase. 24 chromosomes in each daughter nuclear plate. $\times 2120$.

Fig. 4. Belladonna. Homoeotypic telophase. Cell plate appears temporarily and furrowing of cytoplasm takes place. $\times 1310$.

Fig. 5. Belladonna. Pollen tetrads. $\times 1310$.

to be normal (fig. 5). They develop into normal pollen grains, having the ability of germination and fertilisation.

The normal reduction division of the pollen mother cells mentioned above, is observed sometimes also in the other varieties, even in Snowflake, where a very abnormal division, with the consequent formation of abortive pollen grains occurs as usual. It is worthy to note that these varieties of German origin, which are resistant to the mosaic disease, tend to show the reduction division in a more regular manner than the susceptible ones, which have been cultivated hitherto in Hokkaido⁽¹⁾.

Abnormal Reduction Division of the Pollen Mother Cells

As reported by YOUNG (1923) and FUKUDA the abnormal division of the pollen mother cells often occurs in several varieties of the potato plant. The examination of the writer indicates that the following varieties are also to be mentioned in this connection:

1. Snowflake, Green Mountain, Burbank's Seedling, Michigan, American Wonder, Rural New Yorker, Nemuro-Murasaki, Ekishirazu.
2. Gratiola, Parnassia, Pirola, Deodara, Marschal Hindenburg, Turo, Belladonna, Pepo.

The varieties which belong to the former group (1) show the abnormality in higher degree than those of the latter (2). The abnormal division in Ekishirazu will be here described as typical.

Heterotypic division. In the diakinesis there are gemini and separated univalents mixed (fig. 6). On account of the failure of the gemini formation some of the univalent chromosomes come to group together with the bivalents on the equatorial plate. Thus the number of chromosomes in the metaphase is variable. Such cases have been reported often in the hybrids between plants of different chromosome numbers or in the parthenogenetical plants. KIHARA* (1924, pp. 133-137) indicated them summarised under the *Erigeron*-type.

The behaviour of the chromosomes is disturbed and irregularities of various kinds are noticed. In the anaphase and telophase some chromosomes are sometimes left between the two chromosome groups (fig. 7) or many of them are scattered irregularly in the cytoplasm (fig. 8), without passing to the poles. The so-called amitotic figure is observed, which has however really been produced in consequence of the nuclear

(1) According to the writer's observation in the summer of 1926, the normal reduction division can occur in the pollen mother cells of the plants which have been attacked by this disease.

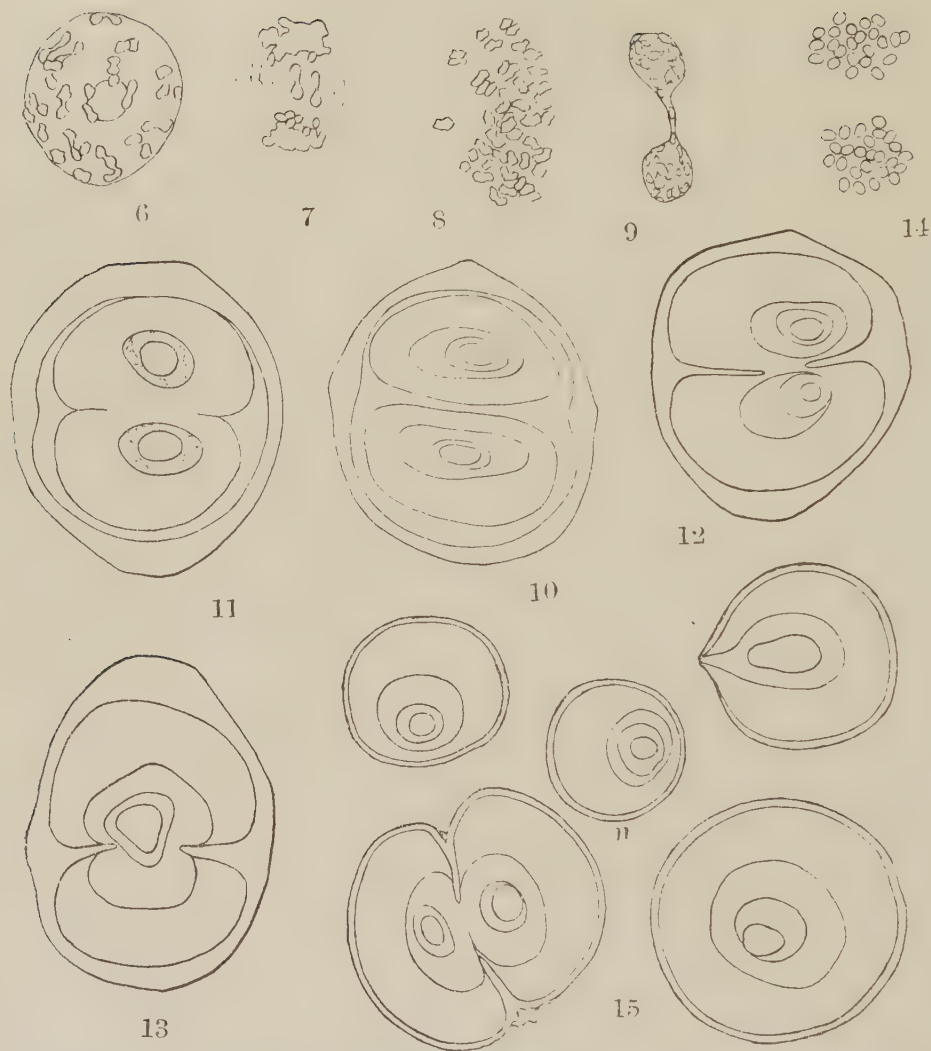


Fig. 6-15: Pollen mother cells of Ekishirazu; the materials were first treated with CARNOY's fluid and fixation was completed with FLEMING's fluid. Stained with HEIDENHAIN's iron-alum haematoxylin. $\times 2080$.

Fig. 6. Diakinesis; univalents mingled with bivalents.

Fig. 7. Abnormal heterotypic anaphase; two bivalents remaining between the two anaphasic chromosomal groups.

Fig. 8. Abnormal heterotypic anaphase; chromosomes scattered in cytoplasm.

Fig. 9. Abnormal reconstruction of a nucleus.

Fig. 10. Dyad cells; both nuclei in perfect resting state.

Fig. 11. Constriction of cytoplasm by the end of the first division, both nuclei stained very weakly.

Fig. 12-13. Centripetal thickening of the mother cell-wall by the end of the first division.

Fig. 14. Homocotypic metaphase. 23 and 25 chromosomes on each daughter nuclear plate.

Fig. 15. Young pollen grains, just after the dissolution of the mother cell-wall. n, normal.

reconstruction from chromosomes distributed irregularly (fig. 9). Such an abnormal course of nuclear division is followed by the reconstruction of nuclei, which reach the perfect resting state. Their substance is stained weakly and the nucleolus is remarkably large (fig. 10).

Dyad-cells or smaller ones in different numbers are directly formed by the constriction of cytoplasm or the centripetal thickening of the mother cell-membrane at the region of the nuclear plate, at the end of the first division (fig. 11, 12). The formation of the separation wall of these kinds generally proceeds independently of the nuclear division, so it may often attack the chromosome group or the newly reconstructed nucleus on both flanks (fig. 13). Cell-division by the formation of the cell-plate is never seen in such abnormal cases.

Homoeotypic division. If in the previous first division such dyad formation occurs as mentioned above, it does not proceed further in the homoeotypic division. Somewhat abnormal second division is, however, sometimes observed, which seems to follow the normal heterotypic division and to be caused by a sudden change of the environmental condition in the corresponding stage. Under the condition, where the first division proceeds normally, the second division occurs equally without any disturbance. On each daughter nuclear plate of one and the same mother cell 23 and 25 chromosomes are frequently found in many varieties (fig. 14). Extreme differences in chromosome number between these two nuclear plates are not met with. From this fact it seems probable that in such an abnormal condition, where chromosomes are distributed in both poles quite unequally, the first division ends in the dyad-formation and can not be followed by the second division.

As a consequence of such abnormal divisions of the pollen mother cells sterile pollen grains of different sizes and shapes are produced (fig. 15). They would be probably formed from monads and dyads, in other words by the furrowing of cytoplasm, the centripetal growth of the mother cell-membrane, the incomplete wall formation, etc. Those pollen grains containing protoplasm are found mingled with those which are empty.

Correlation between the Reduction Division of the Pollen Mother Cells and the Nutritive Condition of the Flower Organ.

The experiments were carried out as follows:

1. Cutting the newly formed tubers;
2. Bending the branch, on which flower buds develop;

3. Cutting leaves and seed tubers;
4. Putting the cut branch in a grape sugar solution.

Such operations frequently caused the abscission of flower buds. When not, the observations recognized no noticeable correlation in the sense termed above, so the report of the results has been omitted.

Influence of Temperature on the Reduction Division of the Pollen Mother Cells

When the attempt was made to determine the chromosome number of *Gratiola*, *Parnassia*, *Pirola*, *Marschal Hindenburg*, *Deodara*, *Tuno*, *Belladonna* and *Pepo* by the iron-acetocarmine method, the writer has many times met with chromosomal elements⁽¹⁾ in different numbers on the first nuclear plate, while in the second metaphase 24 chromosomal elements were clearly observed. That this is not attributable to an error of observation, was ascertained by repeated examinations. A thorough investigation showed us that this really has connection with the influence of temperature, because at lower temperature⁽²⁾ large chromosomal elements appear in smaller numbers and at higher temperature⁽³⁾ the contrary occurs. Moreover it became clear, that in the former case the reduction division of the pollen mother cells and the pollen formation are accomplished normally, but in the latter case the above-mentioned abnormalities of the meiosis occur, which cause naturally the sterility of pollen grains.

For example the result of the observation on the heterotypic metaphase in one and the same plant of *Tuno* will be described here (Table I).

1. 6. VII, 1925. Temperature was relatively low since a few days (17.0° – $20.5^{\circ}\text{C}.$). 18 chromosomal elements of different sizes. Formation of the normal tetrad cells.

2. 10. VII, 1925. Temperature rose somewhat since a few days (22.0° – $26.4^{\circ}\text{C}.$). 19, 21 and 24 chromosomal elements of different sizes. Formation of the normal tetrad cells.

3. 21. VII, 1925. Temperature rose more and more (25.7° – $32.1^{\circ}\text{C}.$). 31 and 33 chromosomal elements. The side view of the equatorial plate

(1) The individual bodies of chromosomes which appear in the diakinesis or are arranged on the nuclear plate, are not necessarily all equivalent in these instances. Some of them may be bivalent, while the others univalent. The total chromosomal value in one pollen mother cell, however, remains constant even in such a special instance.

(2) and (3) Within the limit of temperature, in which the other life phenomena normally occur.

shows gemini mixed with some univalent chromosomes. The first division ends in the dyad-formation, not accompanied by the second division, therefore no normal tetrads are produced.

From the above observations we are able to see, since no chromosome is lost, that when the number of the chromosomal elements is smaller than the haploid, they are partly united into multipartite chromosomes, and if the number is larger than the haploid, the failure of the gemini formation is the cause. Such deviations of the number from the haploid depend mainly on the influence of temperature; at lower temperature the chromosomal differentiation of the former type accompanies the normal division, and at higher temperature that of the latter type takes place followed by the abnormal division. Only the moderate temperature permits perfect gemini formation in the haploid number. In order to prove further, these relations the following experiments were carried out:

EXPERIMENT I

Material: Belladonna. Branches carrying flower buds which appeared to contain pollen mother cells about the synaptic stage, were cut to length of ca. 20 cm. Some branches put in a vase and a glass cylinder containing pieces of ice were covered together with a large bell jar. Such an arrangement was kept near the window in the laboratory and supplied sometimes with ice pieces. The other branches cut from the same plant were kept by the side of this arrangement as the control. The fluctuation of temperature

TABLE I.
Outdoor temperature in July, 1925⁽¹⁾

Date	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Maximum (degrees C.)	17.4	17.4	18.7	20.5	22.0	23.4	22.4	26.4	25.7	27.4	31.5	32.1	25.3	22.9	26.1	30.1	31.6											
Minimum (degrees C.)	12.4	11.3	8.8	13.1	11.6	13.6	13.6	12.4	17.1	17.5	18.2	19.4	15.0	14.6	14.3	16.1	17.3											

(1) The given temperatures have been extracted from the record of the Sapporo Meteorological Station which stands about half a kilometre from the writer's experimental field.

during the course of the experiment was as follows:

TABLE II

July, 1925

Date	29	30			31		
Time	4.30 p.m.	8.30 a.m.	11.0 a.m.	5.0 p.m.	6.30 a.m.	9.0 a.m.	10.30 a.m.
Room-temp.	24°C.	—	28.5°C.	26.0°C.	25.0°C.	25.0°C.	29.0°C.
Bell jar temp.	16.5°C.	21.0°C.	15.5°C.	14.5°C.	19.5°C.	14.0°C.	10.5°C.
Remarks	beginning	supplied with ice		supplied with ice	supplied with ice		observ- ed ⁽¹⁾

After 42 hours the pollen mother cells in division were examined by the iron-acetocarmine method. In the heterotypic metaphase the chromosomal elements shorten and thicken, come closely together, making their counting difficult. In fig. 16 we can, however, distinguish 13 chromosomal elements from each other. Their appearance in such a small number and in large size was not observed in the control materials. On the day previous to the beginning of the experiment, 28th of July (see Table II), 24 chromosomal elements of equal size were observed in the same stage of the reduction division (fig. 17).

EXPERIMENT II

Material: *Tuno* and *Parnassia*. Branches as in the previous experiment were put in a vase kept in a dark basement (14.5°–15.0°C) (Table III).

TABLE III

July 1925

Date	29	30	31
Time	4.4 p.m.	8 a.m.—4 p.m.	12, 30 p.m.
Temperature	14.5°C.	15.0°C.	15.0°C.
Remarks	beginning		observed or fixed

(1) Many of the flower buds fell off under the bell jar.



Fig. 16-20: Iron-acetocarmine preparations of pollen mother cells. $\times 1312$.

Fig. 21-27: Materials fixed with FLEMING's fluid. Stained with HEIDENHAIN's iron-alum haematoxylin. $\times 2120$.

Fig. 16. Belladonna; Exper. I. Heterotypic metaphase. 13 chromosomal elements.

Fig. 17. Belladonna; Exper. I. Control material. Heterotypic metaphase. 24 chromosomal elements-

Fig. 18. Tuno; Exper. I, Heterotypic metaphase. 18 chromosomal elements.

Fig. 19. Tuno; Exper. I. Control material. Heterotypic metaphase. 31 chromosomal elements.

Fig. 20. Parnassia; Exper. II. Heterotypic metaphase. 15 chromosomal elements.

Fig. 21. Parnassia; Exper. II. A hook-shaped tripartite chromosome in the diakinesis.

Fig. 22. Parnassia; Exper. II. A tetrapartite chromosome of open ring shape in the diakinesis.

Fig. 23. Parnassia; Exper. II. A tetrapartite chromosome of closed ring shape in the diakinesis.

Fig. 24. Parnassia; Exper. II. Tetra- and pentapartite chromosomes in the diakinesis.

Fig. 25. Parnassia; Exper. II. A multipartite (probably hexapartite) chromosome of open ring shape in the diakinesis.

Fig. 26. Parnassia; Exper. II. A hexapartite chromosome of closed ring shape in the diakinesis.

Fig. 27. Parnassia. Two interkinetic sister nuclei. 24 chromosomal elements in each daughter nucleus.

The control materials were kept in the laboratory, where the temperature was the same as in Experiment I. The result of observations obtained from the healthy flower buds remaining on the branches by the iron-acetocarmine method, is given in the following.

1. *Tuno*. On the heterotypic metaphasic nuclear plate chromosomal elements are observed in relatively small numbers; for instance, 19 elements in fig. 18. They are larger than those in the control materials in the corresponding stage, in which a larger number than the haploid is discovered (31 in fig. 19).

2. *Parnassia*. In the heterotypic metaphase chromosomal elements come to appear in very small number (for instance, 15 in fig. 20). Counting in the anaphase is impossible, because the chromosomal elements are then too closely massed. The result of the observations in the control is about the same as in *Tuno*.

Investigation with the materials fixed with FLEMMING's solution at the end of the experiment, was also made. Although it was impossible to distinguish each chromosomal element in the heterotypic metaphase, the distribution of chromosomes in the daughter nuclei, each containing 24 (fig. 27), was perfectly confirmed by the observation of the interkinetic nuclei. This indicates that the distribution of chromosomes in the reduction division of the pollen mother cells happens normally at the temperature of such degree as 14.5° – 15°C . In the diakinesis are often found tripartite chromosomes, bent in most cases (fig. 21; Pl. IX, microphoto. 1) but sometimes straight. Other chromosomes united in ring shape or straight line are to be seen, which seem to be tetrapartite, pentapartite or hexapartite (fig. 22, 23, 24, 25, 26 microphoto. 2, 3). These multipartite chromosomes appear sometimes in one and the same nucleus.

EXPERIMENT III

Flower buds growing on a branch were kept in a thermos bottle together with a ERLÉNMEYER's flask containing ice pieces as illustrated in fig. 31. Other branches of the same plant, exposed directly to the atmosphere of the glass house where this experiment was carried out, were taken as the control. *Belladonna* was used in this experiment.

1. In the material which was kept at temperature of 8.5° – 12°C . for 44 hours (fig. 28) the heterotypic metaphase shows chromosomal elements in diminished number as expected (16 in fig. 32; Pl. IX, microphoto. 4). No centripetal growth of the mother cell membrane happens at the region of the equatorial plate. Each group of 24 chromosomes is arranged on

both nuclear plates in the metaphase of the second division (fig. 3). Normal tetrad-formation occurs, but no dyads are produced. In the control the reduction division of the pollen mother cells could not be observed, but it was confirmed that tetrad-cells are formed.

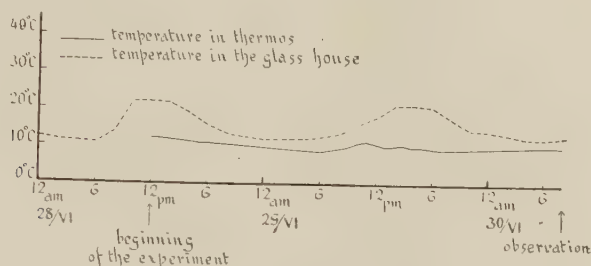


Fig. 28

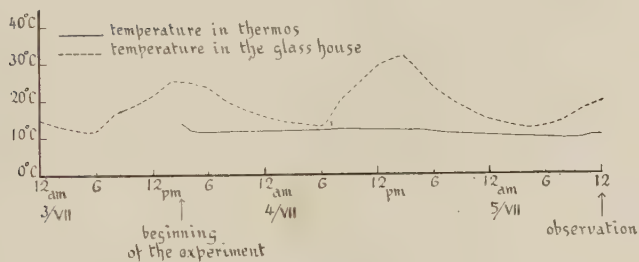


Fig. 29

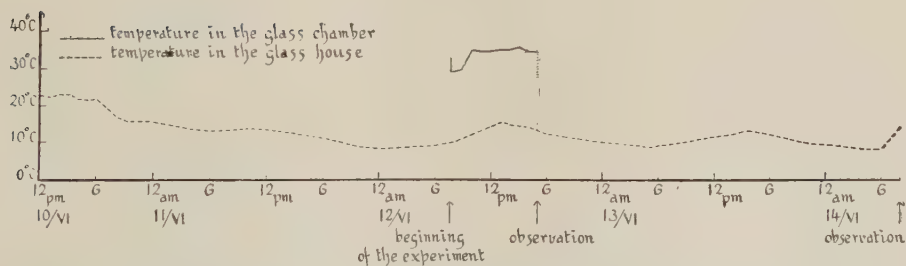


Fig. 30

2. In the material which was kept at the temperature of 9.5° – 12.5°C . for 45 hours (fig. 29), large chromosomal elements in small number come into contact with each other in the heterotypic metaphase. (12, 16, etc. in fig. 33, 34; Pl. IX, microphoto. 5, 6). Normal tetrad-cells are formed. In the control no figure of the meiotic division could be observed, but the dyad-formation was ascertained to occur.

It is now out of question that at lower temperature chromosomal elements come to appear in smaller number and the meiosis proceeds normally. Even in the case of Snowflake, where a very abnormal reduction division of the pollen mother cells usually⁽¹⁾ occurs, it returns at lower temperature (12° – $22^{\circ}\text{C}.$) to normal and the number of chromosomal elements decreases sometimes below the haploid number 24 (ca. 17 in fig. 35). Special attention must be paid to the remarkable fact that some chromosomes, from 4 to 8, are united into a multipartite chromosome which assumes a ring shape (fig. 36, 37; Pl. IX, microphoto. 7, 8.)



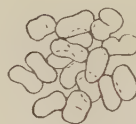
Fig. 31



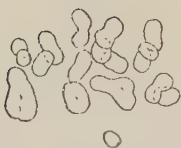
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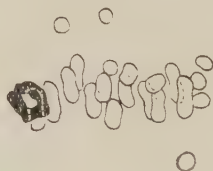
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Fig. 32-37: Iron-acetocarmine preparations of pollen mother cells. $\times 2120$.

Fig. 32. Belladonna; Exper. III. Heterotypic metaphase. 16 chromosomal elements.

Fig. 33. Belladonna; Exper. III. Heterotypic metaphase. 12 chromosomal elements.

Fig. 34. Belladonna; Exper. III. Heterotypic metaphase. 16 chromosomal elements.

Fig. 35. Snowflake. Heterotypic metaphase. About 17 chromosomal elements.

Fig. 36. Snowflake. Heterotypic meta-anaphase. About 22 chromosomal elements.

A hexapartite chromosome of closed ring shape.

Fig. 37. Snowflake. Heterotypic meta-anaphase. About 19 chromosomal elements.
A hexa- or octopartite chromosome of closed ring shape.

(1) It is not rare that the potato plant is cultivated in the region of rather higher temperature.

A similar occurrence has been observed also in the diakinesis in *Parnassia*, and they should possess a common mode of origin in these two examples.

EXPERIMENT IV

A potted plant was placed in a glass chamber of higher temperature (29.5°–35°C.) as represented in fig. 38. The experiment was carried out

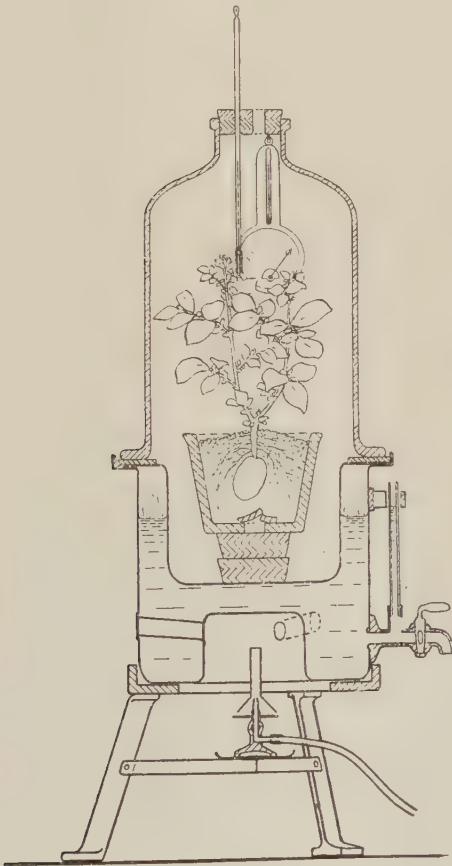


Fig. 38

mostly with Tuno. The control was kept in a glass house, where the temperature fluctuated as shown in fig. 30. By observation after 9 hours it was seen that a mixed group of univalent and bivalent chromosomes comes to appear in the first metaphase. All of these chromosomal elements represent such a variation in number as 27, 38, 45 etc. (fig. 39, 40, 41; Pl. IX, microphoto. 9). It may be possible that some of these univalent chromosomes are the ones which were separated from the constituent chromosomes of gemini by their hasty longitudinal separation, while the others remained in the same condition as in the early stage. The possibility of the former case seems more probable by the fact that in figures which appear to show the anaphasic stage, a number of chromosomal elements which is more than the diploid (48) is observed, e. g. 57 (fig. 42), 59 (fig. 43), 74 (fig.

44), in two groups 34 and 32 (fig. 45 a. b) etc.

During the telophase and interkinesis, the dyad formation proceeds or is completed by the constriction of cytoplasm or the centripetal growth of the mother cell-membrane. After the experiment the plant was transferred to the glass house (8°–13°C). 38 hours after the transfer

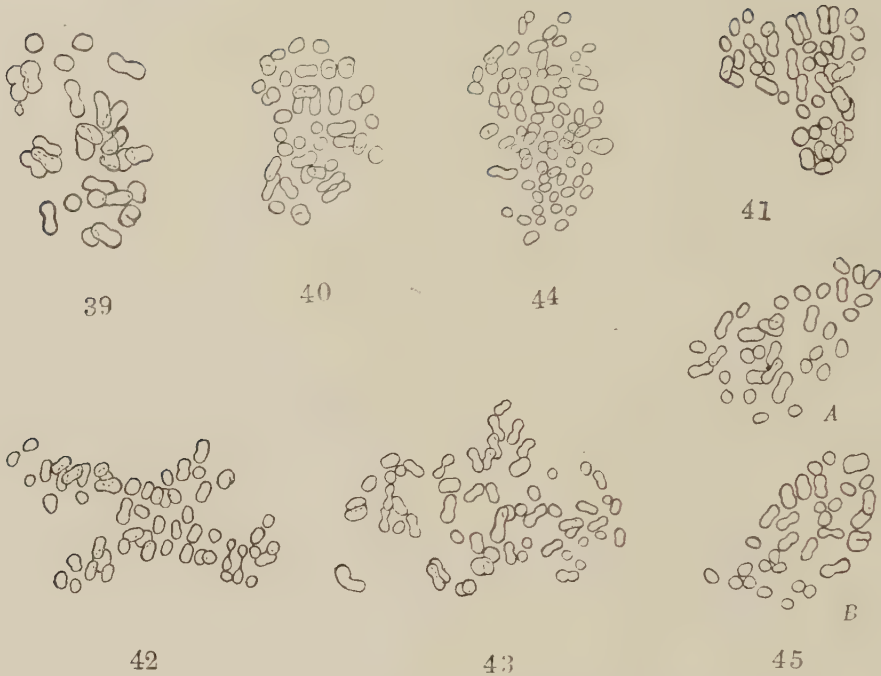


Fig. 39-45: Iron-acetocarmine preparations of pollen mother cells. $\times 2120$.

Fig. 39. Tuno; Exper. IV. Heterotypic metaphase. 27 chromosomal elements.

Fig. 40. Tuno; Exper. IV. Heterotypic metaphase. 38 chromosomal elements.

Fig. 41. Tuno; Exper. IV. Heterotypic metaphase. 45 chromosomal elements.

Fig. 42. Tuno; Exper. IV. A side view of heterotypic anaphase. 57 chromosomal elements.

Fig. 43. Tuno; Exper. IV. A polar view of heterotypic meta-anaphase. 59 chromosomal elements.

Fig. 44. Tuno; Exper. IV. A polar view of heterotypic meta-anaphase. 74 chromosomal elements.

Fig. 45. Tuno; Exper. IV. Heterotypic anaphase. Two chromosomal groups were drawn separately. 34 (upper) and 32 (lower) chromosomal elements.

there were observed many abnormal pollen grains of various shapes⁽¹⁾.

The control showed no figures of the division, and only the normal interkinesis and normal tetrad-cells were seen.

Discussion

Experimental studies on the sterility of the potato plant have been undertaken hitherto by many authors. From the results of these investigations we are generally inclined now to believe that it is neither

(1) These figures are similar to those in fig. 15.

connected with the hybrid nature of the plant nor the nutritive correlation within its body, but rather due to environmental conditions or certain special nature of the plant itself (EAST, 1908, STOUT and CLARK, 1924, YOUNG, 1923, FUKUDA). With regard to the conception about the relation of external factors to the sterility of this plant, the farmers' experience and the scientific researches, especially those of STOUT and CLARK (1924), have shown that in cool weather or a cool locality seeds are produced, but at higher temperature this does not occur. Notwithstanding the fact that FUKUDA and YOUNG have been engaged in the cytological studies on this problem, the question as to what extent pollen sterility could be explained by taking the relation between cytological phenomenon and environmental condition into consideration, remained unsolved⁽¹⁾.

In the present investigation it was proved that the sterility is mainly the result of the abnormal division of the pollen mother-cells, which is caused by higher temperature (25°–35°C.). The pollen grains thus produced are of various shapes and have no germination power⁽²⁾. At lower temperature (15°–20°C.), on the other hand, the reduction division goes on in a regular manner, producing normal pollen grains⁽³⁾. It is not improbable that the development of the flower organ proceeds hand in hand with the progress of the normal meiotic division.

The above-mentioned result of the writer is wholly in agreement with the fact that in U.S.A. the greatest yields of potatoes per acre are in those states where the mean annual temperature is below 45°F.(7°C.), and where the mean of the warmest month is not far from 65°F.(18°C.)⁽⁴⁾. The potato plant must be recognized therefore as a cool-season crop not only from the economical point of view, but also in the biological meaning, provided that the sexual reproduction indicates its original healthy life condition.

Though all the tendencies above described can be recognized throughout the several varieties, it must be remembered that the abnormality of the division is variable according to different varieties. Generally speaking, in those varieties which have been hitherto cultivated in Hokkaido and are very susceptible to the mosaic disease, the abnormal division

(1) YOUNG (1923) is also of opinion that the sterility of the potato plant has the bearing upon the environmental conditions, but the data of the influence of temperature on the reduction division of the pollen mother-cells which he has given, seem inadequate to solve this question, nor did he come to a definite conclusion in this connection. The case where pollen sterility occurs at low temperature was confirmed by BORGSTAM (1922) in *Syringa*.

(2), (3) These were proved by the writer's germination experiment.

(4) SMITH (1915), cited after STUART, *The Potato*, p. 15.

occurs in higher degree than in the resistant ones of German origin. Consequently the nature of plant itself must be also taken into consideration in the present investigation, though surely the influence of temperature is the principal factor in the present case⁽¹⁾.

Another remarkable cytological fact which is found in connection with the influence of temperature and which seems to have the bearing upon several important problems on chromosomes, should not be let pass by untouched.

Through the thorough examination of the pollen mother cells and the somatic cells of root tips of various varieties, FUKUDA and the writer came to find the same chromosome number 24 and 48 as the haploid and the diploid respectively in all of the examined varieties of the potato plant, i.e. the cases where the number of chromosomes is definitely fixed. We meet, however, frequently with those cases where the number of chromosomal elements is variable in the first metaphase and anaphase. The present investigation shows that such a fluctuation of the number also depends on the influence of temperature. At lower temperature chromosomal elements, bivalent and multipartite mixed together appear in number below the haploid 24. At first glance such multipartite chromosomes might appear to be polyvalent ones which are formed by the union of phylogenetically homologous chromosomes, as in triploid and tetraploid *Datura* (BELLING and BLAKESLEE, 1922) and in triploid *Hyacinthus* (BELLING, 1925), if we assume that the potato plant is of polyploid nature. That this is not the case and these multipartite chromosomes are rather formed by the end-to-end union of non-homologous chromosomes, was rendered more probable by the experiments with other plants which was carried out with special reference to the influence of lower temperature. For instance the results with *Tradescantia virginica* will be briefly given here.

If flower buds of this plant are kept at a low temperature (8.5°-10.5°C.) there are found multipartite chromosomes. They should come doubtless owing to the incomplete abstriction⁽²⁾ of a chain formed from non-homologous chromosomes⁽³⁾, because so many homologous ones, sometimes 10, 8, 4, etc. (fig. 46, 47; Pl. IX, microphoto. 10, 11), from which such a large ring or long chain is formed, are not expected to exist.

(1) If one would attempt to classify the varieties of the potato plant according to their fertility, it should be done on the base of materials which are grown under the same environmental condition, especially at the same temperature.

(2) SANDS (1925).

(3) Each two of the components might be homologous.

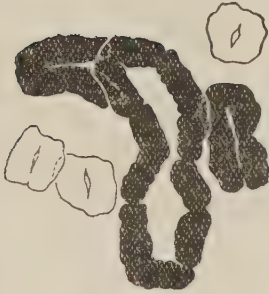


Fig. 46

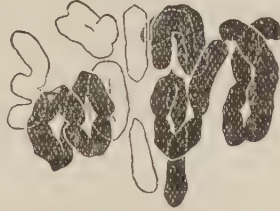


Fig. 47

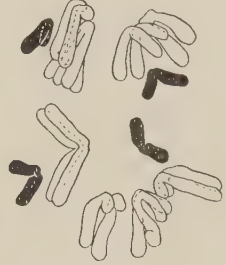


Fig. 48

Fig. 46-48: Iron-acetocarmine preparations of pollen mother cells.

Fig. 46. *Tradescantia virginica*. Late prophase or early metaphase of the heterotypic division at lower temperature. One deca- and two tetrapartite chromosomes, etc. $\times 1060$.

Fig. 47. *Tradescantia virginica*. A side view of heterotypic metaphase at lower temperature. One octo- and two tetrapartite chromosomes, etc. $\times 1060$.

Fig. 48. *Paris quadrifolia* var. *obovata*. Heterotypic anaphase at higher temperature. Two homologous univalents separate longitudinally too early. $\times 630$.

It is quite natural to think that the formation of such multipartite chromosomes in the potato plant is to be explained in the same manner as the above mentioned result of the experiment with *Tradescantia*. They appear in the diakinesis and metaphase of the first division, being variable in their shape, sometimes ring shaped, sometimes bent. The reduction division goes on, nevertheless, in a regular manner, 24 chromosomes being distributed to each nucleus.

Higher temperature causes, however, an entirely different phenomenon in the chromosome number. There often occurs the failure of the gemini formation, in consequence of which the bivalent chromosomes appear mingled with the univalent in the first division. Thus the number of chromosomal elements exceeds the haploid. Moreover it happens that some of the halves of each univalent chromosome are too early separated in the anaphase. In such a case the chromosomal elements which are more than the diploid number 48 are observed. The writer's experiment with other plants, for instance *Paris quadrifolia* var. *obovata* (30°C. for 15 hours, fig. 48; Pl. IX, microphoto. 12) belongs to a similar case.

The haploid number 24 can be determined in the reduction division of the pollen mother cells of the potato plant only at a moderate summer temperature (about 20°C.).

The above-mentioned fact plays no doubt an important part in the determination of the chromosome number not only in the potato plant,

but sometimes also in other plants. The occurrence of the formation of the multipartite chromosomes by the mode of the end-to-end union of non-homologous chromosomes, has been reported recently in several plants by many authors; in *Oenothera* by CLELAND (1922, 1923), in *Rumex acetosella* by MEURMAN (1925) and KIHARA (1925), in *Godetia* by HAKANSSON (1925) and in *Datura* mutant by BELLING and BLAKESLEE (1926). As it is now not very improbable that a similar occurrence might be found in many other cases, these points must be taken into consideration in order to determine the exact chromosome number, especially when the numbers reported by various authors do not agree to each other. Experimental research on this line is now in progress, of which a detailed report is kept for a future occasion.

Summary

1. The male sterility of the potato plant is mainly caused by the influence of higher temperature.

2. At higher temperature (25°–30°C.) the reduction division of the pollen mother cells occurs in an irregular manner, and is not followed by the second division, so that abortive pollen grains are produced. At lower temperature (15°–20°C.) it proceeds normally and fertile pollen grains are produced.

3. The haploid number 24 has been determined in the pollen mother cells of all, the diploid number 48 in the root tips of some varieties.

4. At higher temperature many chromosomes fail to unite into gemini and sometimes the halves of each univalent chromosomes are too early separated in the heterotypic metaphase or anaphase. Therefore the number of chromosomal elements are found to be more than haploid or sometimes more than diploid in these stages.

5. At lower temperature multipartite chromosomes, which seem to be formed most probably from some non-homologous chromosomes by their end-to-end union in chain or ring shape, frequently appear in the diakinesis or metaphase. In such a case the chromosomal elements are found on the heterotypic nuclear plate in smaller number than the haploid.

6. Only a moderate temperature (about 20°C.) permits the exact counting of the chromosome number in the pollen mother-cells.

7. The influence of temperature on the reduction division of the pollen mother-cells has been proved not only in the field plants, but also by experiments in the laboratory and a glass house.

In conclusion the writer wishes to express his cordial thanks to Prof. T. SAKAMURA for his kind suggestions and criticism throughout the work. The writer's thanks are also due to Prof. K. MIYABE and Prof. S. ITO for their kind advice about the phytopathological questions. The writer is equally indebted to Mr. T. NAKAYAMA, who kindly permits to use his fixed materials of Ekishirazu in the present work.

October, 1926

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IMPERIAL UNIVERSITY, SAPPORO

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Explanation of Plate IX

Microphotographs 1-3: LEITZ apochromat objective 2 mm. \times ZEISS compensation ocular 12. $\times 1600$.

Microphotographs 4-11: LEITZ apochromat objective 2 mm. \times periplan ocular 8, with the aid of LEITZ "Makam.". ZETTNOW's fluid filter, twice enlarged. $\times 1420$.

Microphotograph 12: ZEISS apochromat objective 4 mm. \times compensation ocular 12. $\times 640$.

Microphotograph 1, same as fig. 21

2	"	"	"	24
3	"	"	"	25
4	"	"	"	32
5	"	"	"	33
6	"	"	"	34
7	"	"	"	36
8	"	"	"	37
9	"	"	"	40
10	"	"	"	46
11	"	"	"	47
12	"	"	"	48



1



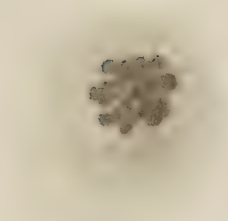
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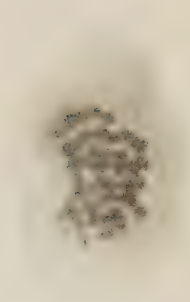
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12

Studies on the Rice Blast Disease⁽¹⁾

By Yosikazu NISIKADO

(Received January 13, 1927)

For many years the writer has been engaged in the investigation of the blast disease of rice in Japan. The investigation was entrusted to the writer by the Bureau of Agriculture, Department of Agriculture and Forestry of Japan, and undertaken at the expense of the Bureau. The following problems were chiefly dealt with in the investigation: (1) the morphological, physiological and taxonomical studies on the causal fungus and the related species, (2) the relation of environmental factors, such as climate, soil, manures etc. to the outbreak of the blast disease, (3) the selection of varieties of rice resistant to the blast, and (4) the physico-chemical studies on the resistance of rice against the blast.

A part of the results of the investigation has already been published under the title, "Studies on the rice blast fungus, I" in the "Berichte des Ôhara Instituts für landwirtschaftliche Forschungen", Bd. I in 1917. Although further investigations will be necessary in several respects the writer thought it well to publish the remainder of the work now already, as circumstances compel him to do so.

The rice blast disease or "Ine Imotibyô" is one of the most serious menaces to the rice industry in Japan. The occurrence of the disease is reported from all the rice growing districts of the globe, *i.e.*, Italy, a part of Austria (now in Yugo-Slavia), Russia (or Union of the Soviet Soc. Rep.), Portugal, United States of America, Brazil, Java, India and Japan.

The rice blast disease is caused by a fungus, *Piricularia Oryzae* BRIOSI et CAVARA. Previous to the present studies, the following plants were known as the hosts of the species of the genus *Piricularia* in Japan: rice (*Oryza sativa* L.), Italian millet (*Setaria italica* BEAUV.), *Setaria glauca* BEAUV., *Zingiber Mioga* ROSC., *Zingiber officinale* ROSC. Afterwards, however, *Costus speciosus* SM., *Leersia hexandra* SW., *Panicum paludosum* ROXB., and *Panicum violascens* KUNTH. were

(1) The present paper is an English résumé of a paper written in Japanese "Ine Imotibyô ni kwansuru Kenkyû". It was reported in "Byôkin-Gaityû Ihô" or "The Bulletin of the Plant Protection", No. 15, II+211 pp., issued March 1, 1926, from the Bureau of Agriculture, Department of Agriculture and Forestry of Japan.

reported as the host plants of the fungus from Formosa by K. SAWADA⁽¹⁾. In the present paper, three species are newly added to the list of the host plants: namely, *Setaria viridis* BEAUV., *Eriochloa villosa* KUNTH., and *Panicum miliaceum* L.

Taxonomically the generic name for the rice blast fungus and the related species is not yet definitely decided, and the name *Piricularia* is adopted by some authors and *Dactylaria* by the others. According to the writer's results of morphological and taxonomical studies, the generic name *Piricularia* seems to be preferable for the rice blast fungus, so that in the writer's previous paper⁽²⁾ that name was used for the causal fungus of the rice blast disease and the related species.

The *Piricularia* species obtained from rice, Italian millet, ginger and other grasses show many differences among themselves morphologically as well as physiologically. The present writer, therefore, adopted already in the previous paper⁽²⁾ in 1917 the name *Piricularia Oryzae* BRIOSI et CAVARA for the rice blast fungus, and *Piricularia grisea* (COOKE) SACC. for the fungus on crab-grass (*Panicum sanguinale* L.). A new name, *Piricularia Setariae* NISIKADO was proposed for the fungus found on Italian millet (*Setaria italica* BEAUV.) and green foxtail (*Setaria viridis* BEAUV.); and *Piricularia Zingiberi* NISIKADO for that on ginger (*Zingiber officinale* ROSC.) as well as that for *Zingiber Mioga* ROSC. In respect to the identification of the species found on *Panicum miliaceum* L. and *Eriochloa villosa* KUNTH., the writer will publish a paper in future.

Several inoculation experiments of rice and various cereals and grasses with the *Piricularia* species, secured from various hosts, were carried out by the writer. A summary of the results of cross inoculations is shown in the following table:

(1) SAWADA, K. Blast of rice plant and its relation to the infective crops and weeds, with description of five species of *Dactylaria*. Government of Formosa, Agr. Exper. Station, Special Bull. No. 16, 78 pp. 2 pls., 1917 (Japanese).

SAWADA, K. Descriptive catalogue of the Formosan fungi. Ditto, Special Bull. No. 19, 695 pp. 40 pls., 1919 (Japanese).

(2) NISIKADO, Y. Studies on the rice blast fungus. I. Berichte d. Ohara Instituts f. landwirtschaftl. Forschungen, Band I. Heft 2. S. 171-217, Taf. III-IV, 1917.

Name of plants inoculated. Name of pathogens and their origins.	<i>Oryza sativa</i> L.	<i>Setaria italica</i> Beauv.	<i>Setaria viridis</i> Beauv.	<i>Panicum sanguinale</i> L.	<i>Panicum miliaceum</i> L.	<i>Zingiber Mioga</i> Rosc.	<i>Zingiber officinale</i> Rosc.	<i>Hordeum sativum</i> Jessen.	<i>Eriochloa villosa</i> Kunth.
<i>Piricularia Oryzae</i> BR. et CAV. from <i>Oryza sativa</i> L.	+	—	—	—	—	—	—	—	—
<i>Piricularia Setariae</i> NISIKADO from <i>Setaria italica</i> BEAUV.	±	+	+	—	—	—	—	—	+
<i>Piricularia Setariae</i> NISIKADO from <i>Setaria viridis</i> BEAUV.	—	+	+	—	—	—	—	—	—
<i>Piricularia grisea</i> (Cooke) SACC. from <i>Panicum sanguinale</i> L.	—	—	—	+	—	—	—	—	—
<i>Piricularia Zingiberi</i> NISIKADO from <i>Zingiber Mioga</i> ROSC.	—	—	—	—	—	+	+	—	—
<i>Piricularia Zingiberi</i> NISIKADO from <i>Zingiber officinale</i> ROSC.	—	—	—	—	—	+	+	—	—
<i>Piricularia</i> sp. from <i>Panicum miliaceum</i> L.	—	—	—	—	+	—	—	—	—
<i>Piricularia</i> sp. from <i>Eriochloa villosa</i> KUNTH.	—	—	—	—	—	—	—	—	+

As stated in the previous paper, the *Piricularia* species obtained from these various hosts grew well on various artificial cultural media. Excellent growth occurred in decoctions of rice plant and other grasses and vegetables; good spore formation was also obtained with the same media. On gelatin media containing rice decoction, the *Piricularia* species liquefied the gelatin.

On agar media containing carbohydrates, the culture became deep olive to olivaceous black according to the species. But on the same media without carbohydrates, such as bouillon agar, it remained colorless. The pigments produced by these species are soluble in glycerine and hydrogen peroxide in water, but not in ordinary organic solvents, such as ether, xylol, etc. The relation of the concentration of carbohydrates in culture media to the growth of the species of *Piricularia* was studied. Among the media containing different percentages of glucose, 3 % glucose medium was the best for the mycelial growth of almost all these species studied. On the media containing 5 and 10 percent or more of glucose, the growth became worse with the increase of percentage.

Thermal relations of the growth of the *Piricularia* species varies according to the species, and even in the same species the variation was

recognizable in different strains. The optimum temperature for the mycelial growth of the species of *Piricularia* seems to be 26–28°C for *Piricularia Oryzae*, *Piricularia Setariae*, and *Piricularia grisea*, and 23–24°C for *Piricularia Zingiberi*. The maximum temperature may be 36–37°C for *Piricularia Oryzae*, *Piricularia Setariae* and *Piricularia grisea*, and 34–35°C for *Piricularia Zingiberi*. The minimum temperature for the growth of all the species of *Piricularia* studied lies between 8–9°C, and the thermal death points for these species are 51–52°C.

The effect of hydrogen-ion concentrations of culture media to the growth of *Piricularia* species was studied. Most of the strains of *Piricularia Oryzae* grew on the media of hydrogen-ion concentration between 5.0 and 10.0 pH values. The growth of the strain Ehime B of *Piricularia Oryzae*, which was reported to show strong pathogenecity started from pH 4.4. Therefore it may be expected that there exist some relations between the pathogenecity and the pH values, for which the strain may be tolerable. This fact seems to demand more extensive studies.

The relations of the growth of *Piricularia Setariae* to the pH values of the culture media were similar to those of *Piricularia Oryzae*.

The *Piricularia* species exhibited in culture a long vitality which lasts more than 400 days. In dry conditions, the spores of *Piricularia Oryzae* maintained their vitality from the autumn till the next summer during about 8 months, so that the spores may be a source of early infections. The spores of the rice blast fungus attached on the surface of the glumes of rice may be sterilized easily with rather dilute fungicides. On the contrary it is very difficult to sterilize the mycelium which has penetrated into the tissues of the nodules of the culms or the grains.

The *Piricularia* species were not able to grow without oxygen supply, and they showed no growth in carbon dioxide gas.

The season of the year is the most efficient environmental factor for the occurrence of the rice blast disease. When the weather conditions of June to July recover after long continued rainy and cool days, severe outbreak of the blast disease usually takes place on rice leaves. The disease also attacks the ears, especially the necks and causes "rotten neck" when the weather is rainy and cool in the flowering season in September.

The quality and quantity of manures are the other most influential factors for the occurrence of the leaf blast disease of rice. The most severe occurrence of the leaf blast disease is met with in the fields where a large amount of green manures, such as "Genge" or *Astragalus sinicus*

was applied, especially in the case of heavy soil. On the contrary, the rotten neck disease of rice occurs in sandy soil, when green manures are given in large quantity. According to the results of the writer's field experiments, the addition of lime, gypsum or calcium carbonate etc. to the manures, or the proper application of super-phosphate prevents the occurrence of the blast disease of rice, at least reduces its occurrence.

The leaf blast disease of rice occurs in the fields of heavy loam or clay soil. But the rotten neck occurs in sandy soil with good drainage. Drainage as a means of checking the blast disease was a subject discussed by many authors: some recommended the drainage as a control measure for the blast disease, and others denied its effectiveness. The results of the writer's experiments show that the drainage in the field of sandy soil does not only not check the occurrence of the blast, but also induces the progress of the disease. On the contrary, in the heavy soil, the moderate drainage checks the blast, at least it does not induce its progress.

The results of the writer's repeated inoculation experiments of about 430 varieties of cultivated rice with various strains of *Piricularia Oryzae* Br. et Cav. show that the following varieties are comparatively resistant to the blast disease, none being entirely immune:

Aikoku; Aikoku No. 1; Aikoku No. 2; Mubô Aikoku (Aikoku without awns); Akage (Hokkaidô); Asahi; Benkei No. 1045; Hawaiian rice No. 1; Do. No. 154; Hinode; Kamezi; Hukui Issyaku-moti; Kinai-Sizyô Nakate 56 (mid-season variety No. 56, selected at the Kinai Branch Station, Agricultural Experiment Station); Kinai-Sizyô Okute 31 (late variety No. 31, selected at the above station); Do. 32; Do. 33; Do. 35; Do. 42; Do. 43; Kinai-sizyô, No. 167; Do. 172; Murasaki-Rokusuke; Ryûsyû (Formosan rice); Senkoku No. 11; Do. 130; Do. 215; Do. 225; Do. 233; Do. 254; Sensyô (upland variety); Sikoku No. 12; Do. 15; Yama-zyû-wase, etc.

The hydrogen-ion concentrations of the infusion or the press juice of leaves of about 80 varieties of rice at various growing seasons were determined colorimetrically as well as electrometrically by the writer. The leaf juice of majorities of these varieties was slightly acid, and showed pH values ranging from 5.5 to 6.5. Only some extreme ones showed pH 5.04-6.83. From the comparisons of the pH values of susceptible and resistant varieties of rice, the writer was not able to find any consistent correlations between the resistance and the pH values of the leaf juice of the rice plants. Among the varieties resistant to the blast disease, however, there were some, which showed the pH value

near the acid limits (pH 4.4-5.0) of the growth of the blast fungus, *Pyricularia Oryzae*. In some cases of resistant varieties, therefore, the resistance to the blast disease may be ascribed to the acidity of the leaf juice.

December 30, 1926

ÔHARA INSTITUTE FOR AGRICULTURAL RESEARCH,
KURASHIKI, OKAYAMA, JAPAN

Weitere Studien über die moderierende Rolle der organischen Salze und des Phosphats bei der Kultur von *Aspergillus niger*

Von Tetsu SAKAMURA

Professor der Pflanzenphysiologie an der Hokkaido Kaiserlichen Universität, Sapporo

Mit 2 Figuren

(Eingegangen am 13. Januar 1927)

In meiner früheren Arbeit (1924) über die Kultur von *Aspergillus niger* habe ich folgende Ergebnisse mitgeteilt:

Durch Zusatz des spezifischen Puffers, z.B. K-Oxalat, K-Citrat, K-Tartarat oder K-Phosphat, zur Kulturlösung, wird die Erhöhung der H-Ionenkonzentration während des Pilzwachstums mehr oder weniger gehemmt, was auf das Wachstum günstig wirkt. Die starke Pufferwirkung sowie das aufs neue auftretende Neutralisationsvermögen der Kulturlösung ruft andererseits leicht, ja selbst in höher Acidität, die Oxalsäurebildung durch den Pilz hervor, die in ökonomischer Hinsicht den Pilz sehr benachteiligt. Eine günstige Harmonie zwischen der Pufferwirkung und der Oxalsäurebildung gestattet *Aspergillus niger* üppiges Wachstum.

Fast zur selben Zeit veröffentlichte BACH die Arbeiten (1924 a, b und 1925), worin er eine ähnliche Tatsache mitteilte, nämlich dass das Mycelwachstum von *Aspergillus repens* durch Zusatz von Na-Citrat als Puffer stark begünstigt wird.

Man dürfte aber gegen die Hauptrolle der zugesetzten organischen Salze als Puffer Bedenken vorbringen und eine ausschlaggebende Bedeutung dabei eher ihren Diesten, als die C-Quelle beimessen; während ich (1924, S. 98) und BACH (1925, S. 53) aus verschiedenen Gründen kein besonderes Hauptgewicht auf den letzten Punkt gelegt haben. Solche Frage dürfte vielleicht auch bei Zusatz von Phosphat vorgelegt werden. In der Tat sagte PREIFFER (1926) in seiner kritischen Besprechung meiner Arbeit: „Ref. hält die Frage nicht für ausreichend beantwortet, ob die als Puffer verwendeten organischen Salze allein oder in erster Linie als solche wirksam werden, oder ob sie auch als

C-Quelle für den Pilz dienen. Der Hinweis auf die gen. älteren Arbeiten, dass die letztere Verwendung nur bei Mangel ausreichender Zuckermengen in der Kulturlösung statthabe, dürfte keine genügende Basis für solch weitgehende Schlussfolgerung liefern“ (S. 157).

Da diese Frage noch genauer beantwortet werden muss und ich selbst unterdessen mit PFEIFFER die ältere Auffassung, dass der Konsum der organischen Salze erst bei Zuckermangel beginnt, für keine genügende Basis für meinen Schluss hielte, habe ich vorliegende Arbeit angestellt, um meine frühere Arbeit noch zu ergänzen. Das Ergebnis zeigt die Richtigkeit des Schlusses meiner früheren Arbeit, nämlich dass die zugesetzten organischen Salze und Phosphat hauptsächlich als Puffer dienen, aber keine Hauptrolle als Nährstoffe spielen.

Methoden

Die Methoden der Kultur und der chemischen Analyse sind im grossen und ganzen gleich denjenigen in der früheren Arbeit (S. 67-71) mit nur einigen Ausnahmen. Ich bediente mich einer synthetischen anorganischen Nährlösung (Grundlösung), die folgende Zusammensetzung zeigt:

Ammoniumnitrat (NH_4NO_3)	4 g
Monokaliumphosphat (KH_2PO_4)	2 g
Magnesiumsulfat ($\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$)	1 g
Eisenchlorid (FeCl_3) (2 Proz.)	ein Tropfen
Umdestilliertes Wasser	100 ccm

Dazu wurde Glukose in den meisten Fällen als C-Quelle verwendet. Da die Karamelisierung der Glukose bei Sterilisation in einer alkalischen Mischlösung oder von schwacher Acidität geschieht, wie bei Zusatz von Phosphat, Citrat u.a. als Puffer, und diese die Mycelentwicklung beeinflusst, waren die Grundlösung, Glukoselösung und Pufferlösung getrennt der Sterilisation unterworfen worden, bevor sie zusammengemischt wurden, um das Effekt der Karamelisierung aus unserer Erwägung auszuschalten.

Die Kulturlösung wurde mit dem Pilz besät, indem 1 ccm einer konzentrierten Sporensuspension mit einer sterilisierten Pipette rasch hinzugefügt wurden. Die Konidien stammten von Mycel ab, das auf 2 Proz. festen Agar-Böden mit folgender Zusammensetzung rein gezüchtet war:

Grundlösung	25 ccm
Saccharoselösung (10 Proz.)	50 ccm
NaH_2PO_4 (m/5)	10 ccm
Na_2HPO_4 (m/5)	15 ccm

Aus diesen Agarkulturen konnten die Konidien immer in genügender Menge entnommen werden⁽¹⁾.

Nach der Aussat wurden die Kulturen in den Thermostaten gestellt und die Temperatur auf 30–31°C reguliert.

In der vorliegenden Arbeit wurde nur ein und einziger Stamm von *Aspergillus niger* als Versuchspflanze verwendet, deren Material in der früheren Arbeit Herr Prof. HANZAWA freundlich mir überlassen hat.

Glukose-Bestimmung: 5 oder 10 ccm des auf 500 ccm verdünnten Filtrates wurden nochmals auf 20 ccm verdünnt und diese Lösung als Probe verwendet. Die Glukose wurde nach der BERTRANDSchen Methode volumetrisch bestimmt und die Mengen des Zuckers in den Proben (10 ccm genommen)⁽²⁾ mit der für die Titration verbrauchten ccm 0,5 proz. Kaliumpermanganatlösung vergleichsweise angegeben. 1 ccm der verwendeten Permanganatlösung war äquivalent mit 9,94 mg Kupfer.

Oxalsäurebestimmung geschah etwas anders als in der früheren Arbeit; die Methode wird später am betreffenden Ort angegeben.

Organische Salze als Puffer

Dass organische Salze als die C-Quelle für *Aspergillus niger* im allgemeinen dem Zucker nachstehen, ist eine bekannte Tatsache, und NIKITINSKY (1994, S. 26–27) hat dies teils darauf zurückgeführt, dass die beim Verbrauch der organischen Säure disponibel werdende Alkali auf die Pilzentwicklung schädig einwirkt. Ausser solcher sekundären Beziehung muss der untergeordnete Nährwert der organischen Säure im Vergleich mit dem Zucker selbstverständlich in Betracht gezogen.

Es wurde in den folgenden Versuchen untersucht, in welchem Grade Citrat bezw. Citronensäure allein als C-Quelle bei verschiedenen Aciditäten durch den Pilz benutzt werden kann.

(1) Bei wiederholter Kultur des Pilzes auf den die Glukose-Grundlösung enthaltenden festen Agar-Böden, die in alkaliarmen Reagenzgläser hergestellt wurden, wurde dagegen die Konidienbildung immer ärmer und schwächer.

(2) Wenn beim Zusatz grösserer Zuckermenge 5 ccm aus dem verdünnten Filtrat als Probe genommen wurde, wurde die titrierte Menge der KMnO_4 -Lösung eingeklammert angegeben.

VERSUCH I

Kulturlösungen :	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Grundlösung	25	25	25	25	25	25	25	25
Citronensäure (n/2)	50	50	50	50	50	50	50	50
NaOH (normal)	25	23	20	18	15	10	5	0
Umdest. Wasser	0	2	5	7	10	15	20	25
Summe (ccm)	100	100	100	100	100	100	100	100
pH	6,2	5,8	5,4	5,0	4,2	3,9	2,8	2,3

TABELLE I

Kultur	Kulturdauer (Tag)	Pilzgewicht (g)	pH		Oxalsäure
			anfänglich	final	
1	17	0,062	6,2	6,6	++
2	17	0,069	5,8	6,1	+
3	17	0,081	5,4	5,8	++
4	17	0,098	5,0	5,4	+
5	17	0,122	4,2	5,0	+
6	17	0,242	3,9	4,8	++
7	17	0,384	2,8	4,7	++
8	17	0,386	2,3	2,4	—

Obwohl in diesem Versuch der Pilz nur einmal geerntet wurde und der Nachweis der Citronensäure nicht ausgeführt wurde, ist es nicht unbegreiflich, dass der C-Vorrat noch nicht ganz erschöpft wurde. Dies kann man daran ersehen, dass in freigelassenen Filtraten entwickelte sich ein Pilz von unbekannter Stamme. Aus den obigen Versuch geht es hervor, dass *Aspergillus niger* Citronensäure desto besser verarbeitet, je saurer die Kulturlösung reagiert. In den Lösungen von pH 5,5–6,0, die durch Zusatz von K-Citrat als Puffer in der früheren Arbeit hergestellt wurden, sollte Citronensäure wenigstens in früheren Wachstumsstadien nur unmerklich konsumiert werden.⁽¹⁾ Auch aus dem folgenden Versuche, wo die Kultur etwas länger dauerte, kann man denselben Resultat ersehen.

(1) BACH (1925, S. 53) hat auch festgestellt, dass Citronensäure eine schlechte C-Quelle für *Aspergillus* ist.

VERSUCH II

Kulturlösungen:	(1)	(2)	(3)
Grundlösung	25	25	25
Citronensäure (n/2)	50	50	50
NaOH (normal)	20	15	5
Umdest. Wasser	5	10	20
Summe (ccm)	100	100	100
pH	5,4	4,2	2,8

TABELLE II

Kultur	Kulturdauer (Tag)	Pilzgewicht (g)	pH		Oxalsäure
			anfänglich	final	
1-1	7	0,011	5,4	5,4	—
2-1	7	0,013	4,2	4,6	—
3-1	7	0,039	2,8	2,9	—
1-2	10	0,042	5,4	5,6	+
2-2	10	0,055	4,2	5,0	+
3-2	10	0,241	2,8	3,5	+
1-3	12	0,043	5,4	5,5	+
2-3	12	0,049	4,2	4,8	+
3-3	12	0,237	2,8	3,5	++
1-4	20	0,201	5,4	7,2	+++
2-4	20	0,225	4,2	7,3	+++
3-4	20	0,324	2,8	6,5	++

Die Tatsache, dass in der früheren Arbeit durch Zusatz von K-Citrat die Pilzernte 2–4fach vermehrt wurde, kann nicht durch die Mengenzunahme der C-Quelle allein erklärt werden. Die vorwiegende Bedeutung der Pufferwirkung muss dabei in erster Linie betont werden. Diese Auffassung wird durch den folgenden Versuch noch wahrscheinlicher gemacht.

Nehmen wir an, dass der Nährwert einer C-Quelle der Verbrennungswärme proportional ist, stillschweigend von seiner molekularen Eigenschaft, so stellt sich Glukose eine etwa 1,4fach bessere C-Quelle als Citronensäure dar⁽¹⁾. Da es dazu noch in struktureller Beziehung nicht mehr bezweifelt wird, dass Glukose durch *Aspergillus niger* besser benutzt werden kann als Citronensäure, dürfte man eine günstigere Pilzentwicklung dem überschüssigen Zusatz der ersteren erwarten als demjenigen der letzteren in isothermer oder in weniger Menge, wenn die zugesetzte

(1) Molare Verbrennungswärme beträgt 673,7 Kg-kal. bei Glukose und 475,0 Kg-kal bei Citronensäure (LANDOLT-BÖRNSTEIN, 1912).

VERSUCH III

Kulturlösungen :	(1)	(2)
Grundlösung	25	25
Glukoselösung (m/2)	50	50
Na-Citrat (n/4)	0	25
Glukoselösung (m/2)	10	0
Umdest. Wasser	15	0
Summe (ccm)	100	100
pH	4,2	5,7
Glukose in der Kontrolle (ccm KMnO_4)	(10,35) ⁽¹⁾	16,3
Verbrennungswärme von 10 ccm m/2 Glukoselösung = 3,37 Kg-kal.		
,, „ 25 ccm n/4 Citronensäure = 0,99 Kg-kal.		

TABELLE III

Kultur	Kulturdauer (Tag)	Pilzgewicht (g)	pH	Oxalsäure	Glukose (ccm KMnO_4)
1	3	0,888	1,8	—	13,2
2	3	0,904	3,9	—	9,8
1	5	1,965	1,5	—	3,2
2	5	2,056	2,6	—	0,7
1	5 ^T 2 ^{St.}	2,067	1,6	—	1,7
2	5 ^T 2 ^{St.}	2,145	2,6	—	0,3

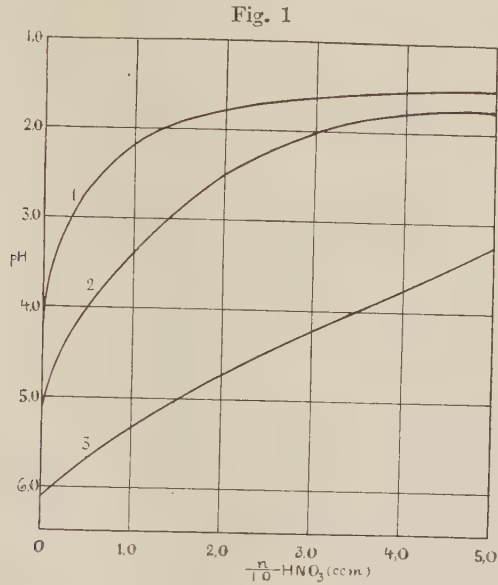
Citronensäure bzw. Citrat nur als ein Nährstoff betrachtet würde. Dass das aber tatsächlich nicht der Fall ist, ist aus dem Resultat des folgenden Versuchs ersichtlich.

Das als Puffer zugesetzte Citrat kann möglicherweise durch den Pilz auch als C-Quelle benutzt werden, was aber kein Grund dafür sein kann, dass die Hauptrolle dieses Salzes als Puffer unterschätzt wird. Aus dem bisherigen Versuchen kann man sagen, dass die Möglichkeit der Wirkung von Citrat als Puffer in der Kulturlösung immer grösser geworden ist.

Dass das Puffervermögen der Kulturlösung im allgemeinen durch Zusatz von Citrat, Oxalat, Phosphat u.a. vermehrt werden kann, kann durch die Titration mit n/10 HCl oder n/10 HNO_3 nachgewiesen und durch die Darstellung der Titrationskurve klar begreiflich gemacht werden. In der früheren Arbeit habe ich aber die graphische Darstellung solcher Titrationskurven für überflüssig gehalten und nicht gezeigt (S.

(1) 5 ccm als Probe genommen.

75). Da ich leider ein Missverständnis von W. MEVIUS bei seiner Besprechung⁽¹⁾ an diesem Punkte meiner Arbeit gefunden habe, so möchte ich hier nicht versäumen die Titrationskurve der Grundlösung und der pufferhaltigen Kulturlösungen graphisch darzustellen⁽²⁾. (Fig. 1).



Kulturlösungen:	(1)	(2)	(3)	{ Kulturlösung 5 ccm n/10 HNO ₃ 0-5 ccm auf 10 ccm verdünnt
Grundlösung	25	25	25	
Glukoselösung	50	50	50	
K-Oxalat (n/2)		25		
K-Citrat (n/2)			25	
Umdest. Wasser	25			
Summe (ccm)	100	100	100	

In der früheren Arbeit habe ich mehr oder weniger starke puffernde Wirkung von K-Oxalat bestätigt, und die Tatsache gefunden, dass die Menge des zugesetzten Oxalats durch das Gedeihen des Pilzes in gewissen Wachstumsstadien nicht merklich verändert wird (S. 79)⁽³⁾. Nun will ich hier einige Resultate aus den damaligen Versuchen wiedergeben, um dieses Verhältnis etwas klar zu zeigen.

(1) Zeitschr. f. Bot. Bd. 18, S. 192, 1926.

(2) Siehe auch BACH (1925) und ГОРОН (1925).

(3) Auch meine nachherigen Untersuchungen zeigten, dass Oxalsäure als eine schlechte C-Quelle für *Aspergillus niger* sich auszeichnet, indem das Mycel bei verschiedenen pH-Werten darin nur unmessbar sich entwickelt.

· AUS VERSUCH II DER FRÜHEREN ARBEIT

Kulturlösungen :	(2)	(3)
Spez. Grundlösung	25	25
Glukoselösung (m/2)	50	50
K-Oxalat (normal)	0	25
K-Oxalat (n/4)	25	0
Summe (ccm)	100	100
pH	5,32	5,61
Glukose in der Kontrolle (ccm KMnO_4)	16,5	16,6
Oxalsäure in der Kontrolle (ccm n/10)	62,5	250,0

TABELLE IV

Kultur	Kulturdauer (Tag)	Pilzgewicht (g)	pH	erzeugte od. verbrauchte (-) Oxalsäure (ccm n/10)	Glukose (ccm KMnO_4)
2 {	7	0,764	3,7	0	9,8
	14	1,293	3,4	-5,0	0,9
	21	1,256	4,4	-3,0	0
3 {	7	1,525	4,3	0	3,6
	14	1,364	5,4	0	0
	21	1,089	6,8	5,5	0

AUS VERSUCH III DER FRÜHEREN ARBEIT

Kulturlösung :	(3)
Grundlösung	25
Glukoselösung (molar)	50
K-Oxalat (normal)	25
Summe (ccm)	100
pH	5,1
Glukose in der Kontrolle (ccm KMnO_4)	16,9
Oxalsäure in der Kontrolle (ccm n/10)	250,0

TABELLE V

Kulturdauer (Tag)	Pilzgewicht (g)	pH	verbrauchte (-) Oxalsäure (ccm n/10)	Glukose (ccm KMnO_4)
5	1,881	3,7	- 1,25	11,9
10	3,631	2,5	-65,0	2,6
15	3,457	3,1	-65,0	0
24	3,202	4,4	-70,0	0

Diese Versuchsergebnisse, wenn einige kleine Versuchsfehler vernachlässigt werden, weisen darauf hin, dass die Verarbeitung der Oxalsäure durch *Aspergillus niger* vom pH der Kulturlösung abhängig ist. Der Verbrauch geschieht nur in der Lösung, deren pH kleiner als etwa 3,5 ist. In der niederen Acidität ($\text{pH} > 3,5$) ist sogar der ausgewachsene Pilz nicht imstande, die Oxalsäure zu konsumieren. Es muss sehr erforderlich sein, dieses Verhältnis des Oxalsäurekonsums noch genauer zu untersuchen, weil die moderierende Rolle des zugesetzten aber nicht verbrauchten Oxalats dadurch viel deutlicher bestätigt werden kann.

Die Oxalsäurebestimmung geschah in vorliegender Arbeit schnell und in befriedigender Weise etwas anders als in der früheren.

10–20 ccm des auf 500 ccm verdünnten Filtrats wurden als Probe in einem Becherglas gefüllt und Calciumchlorid und 20 proz. Essigsäure zugesetzt. Das Becherglas wird stehen gelassen und der Niederschlag nach Verlauf einer Nacht unter Verwendung von Glasfilter (3G 3/ < 7 von SCHOTT und GEN., Jena) abfiltriert, sodann mit Wasser ausgewaschen und mit Salzsäure aufgelöst. Nach Verdünnung der Lösung mit Wasser von 70°C auf etwa 20 ccm, fügte ich 10 ccm verdünnte Schwefelsäure (1:4) hinzu und titrierte mit n/10 Kaliumpermanganatlösung. Aus der nötigen Menge der Permanganatlösung wurde die gesamte Menge von Oxalsäure berechnet und mit der Zahl der ccm n/10 Lösung bezeichnet.

VERSUCH IV

Kulturlösungen :	(1)	(2)
Grundlösung	25	25
Glukoselösung (m/2)	50	50
Umdest. Wasser	25	0
K-Oxalat (n/2)	0	25
Summe (ccm)	100	100
pH	4,2	5,2
Glukose in der Kontrolle (ccm KMnO_4)	16,3	16,3
Oxalsäure in der Kontrolle (ccm n/10)	0	125,0

TABELLE VI

Kultur	Kulturdauer (Tag)	Pilzgewicht (g)	pH	verbrauchte(-) Oxalsäure (ccm n/10)	Glukose (ccm KMnO ₄)
1	2	0,055	3,4	0	15,5
2	2	0,188	4,4	0	15,1
1	3	0,165	2,8	0	15,0
2	3	1,009	3,6	0	10,3
1	3 ^T 4 St	0,269	2,7	0	14,1
2	3 ^T 4 St	1,495	3,2	0	7,3
1	4	0,606	2,3	0	12,4
2	4	1,979	2,8	-15,0	3,0
1	5	1,218	1,8	0	7,1
2	5	2,131	2,9	-15,0	2,2
1	6	1,393	1,7	0	5,2
2	6	2,086	3,4	-36,0	0,5
1	7	1,458	1,7	0	4,7
2	7	1,958	3,7	-38,0	0
1	8	1,875	1,7	0	2,1
2	8	1,662	3,9	-40,0	0
1	11	1,692	1,5	0	0
2	11	1,643	4,8	-38,0	0

Auch in diesem Versuch lässt sich der Grenzwert des Oxalsäurekonsums pH 3,2-3,4 bestimmen. Aus diesem Versuch auch geht es hervor, dass das Mycelwachstum in der Kultur mit Oxalatzusatz merklich begünstigt wurde, worin die Oxalsäure noch gar nicht verarbeitet wurde.

VERSUCH V

Kulturlösungen :	(1)	(2)	(3)	(4)
Grundlösung	25	25	25	25
Glukoselösung (m/2)	50	62,5	50	25
Umdest. Wasser	25	12,5	0	25
K-Oxalat (n/2)	0	0	25	25
Summe (ccm)	100	100	100	100
pH	4,2	4,2	5,2	5,2
Glukose in der Kontrolle (ccm KMnO_4)	16,3	(10,9) ⁽¹⁾	16,4	9,0
Oxalsäure in der Kontrolle (ccm n/10)	0	0	125,0	125,0

Überschüssige Glukose (12,5 ccm m/2) in der Kulturlösung (2) ist äquimolar dem K-Oxalat von 25 ccm, dessen Verbrennungswärme aber viel kleiner ist als diejenige von Glukose. Die Kulturlösung (4) enthält die C-Quelle in der geringsten Menge.

TABELLE VII

Kultur	Kulturdauer (Tag)	Pilzgewicht (g)	pH	verbrauchte(−) Oxalsäure (ccm n/10)	Glukose (ccm KMnO_4)
1	3	0,577	2,3	0	12,5
2	3	0,524	2,3	0	(9,1) ⁽²⁾
3	3	1,498	3,0	−5,0	6,7
4	3	0,879	3,5	0	2,3
3	6	1,976	2,8	−15,0	0,6
4	6	0,931	3,5	0	0

Dasselbe Verhältnis bezüglich des Verbrauchs der Oxalsäure und der moderierende Rolle des K-Oxalats wie im vorigen Versuche ist hier wiederum ersichtlich. Besonders in der Kulturlösung (4) wurde Oxalsäure im Verlauf der Kultur nie benutzt, trotzdem Glukose erschöpft wurde und das Mycel ziemlich üppig ausgewachsen war. Dies beruht wahrscheinlich darauf, dass die Acidität der Kulturlösung über pH 3,5 hinauf sich nicht erhöhte. Dieselbe Tatsache kann man auch in folgenden Versuchen VI und VIII bestätigt finden.

Dass die günstige Wirkung des zugesetzten K-Oxalats auf Mycelwachstum, nicht den dabei dissoziierten K-Ionen zuzuschreiben ist, kann man aus dem folgenden Versuch ersehen.

(1) und (2) 5 ccm als Probe genommen.

VERSUCH VI

Kulturlösungen :	(1)	(2)	(3)	(4)
Grundlösung	25	25	25	25
Glukoselösung (m/2)	50	50	50	50
Umdest. Wasser	25	0	0	0
K-Oxalat (n/2)	0	25	0	0
KCl (n/2)	0	0	25	0
NaCl (n/2)	0	0	0	25
Summe (ccm)	100	100	100	100
pH	4,2	5,2	4,2	4,2
Glukose in der Kontrolle (ccm KMnO_4)	16,3	16,3	16,3	16,3
Oxalsäure in der Kontrolle (ccm n/10)	0	125,0	0	0

TABELLE VIII

Kultur	Kulturdauer (Tag)	Pilzgewicht (g)	pH	verbraucht(—) Oxalsäure (ccm n/10)	Glukose (ccm KMnO_4)
1	3	0,419	2,4	0	13,8
2	3	0,801	3,7	-0,25	11,9
3	3	0,392	2,4	0	14,0
4	3	0,483	2,3	0	13,3
1	3 ^T 6 St	0,609	2,2	0	12,1
2	3 ^T 6 St	1,357	3,2	-1,0	7,4
3	3 ^T 6 St	0,573	2,2	0	12,1
4	3 ^T 6 St	0,602	2,2	0	12,1

Der pH-Wert des Filtrates stellt im allgemeinen nicht denjenigen dar, den die Kulturlösung am Berührungsteil mit der Pilzdecke auszeichnet. Da die Ausgleichung des Unterschiedes der H-Ionenkonzentration in einer Kulturlösung umso langsamer fortschreitet, je die Kulturlösung tiefer behalten wird, ist es vorteilhafter für die exakte Bestimmung der Grenzacidität des Oxalsäurekonsums, mit der Kulturlösung von dünner Schicht zu arbeiten.

VERSUCH VII

Kulturlösung :	(1)	(2)
Grundlösung	12,5	12,5
Glukoselösung (m/2)	25,0	25,0
Umdest. Wasser	12,5	0
K-Oxalat (n/2)	0	12,5
Summe (ccm)	50,0	50,0
pH	4,2	5,2
Oxalsäure in der Kontrolle (ccm n/10)	0	62,5

TABELLE IX

Kultur	Kulturdauer (Tag)	Pilzgewicht (g)	pH	verbrauchte(-) Oxalsäure (ccm n/10)	Glukose
1	2	0,270	2,1	0	+
2	2	0,375	3,4	0	+
1	2 ^T 1 St	0,349	1,9	0	+
2	2 ^T 1 St	0,537	3,0	-1,25	+
1	2 ^T 3 St	0,521	1,9	0	+
2	2 ^T 3 St	0,683	2,8	-2,5	+
1	3	0,685	1,7	0	+
2	3	1,033	2,4	-18,75	-
1	4	0,932	1,7	0	-
2	4	1,080	3,0	-21,25	-
1	5	0,901	1,7	0	-
2	5	0,752	3,8	-27,5	-

VERSUCH VIII.

Kulturlösungen :	(1)	(2)
Grundlösung	12,5	12,5
Glukoselösung (m/2)	25,0	0
Glukoselösung (m/4)	0	25,0
Umdest. Wasser	12,5	0
K-Oxalat (n/2)	0	12,5
Summe (ccm)	50,0	50,0
pH	4,2	5,2
Oxalsäure in der Kontrolle (ccm n/10)	0	62,5

TABELLE X

Kultur	Kulturdauer (Tag)	Pilzgewicht (g)	pH	verbrauchte(-) Oxalsäure (ccm n/10)	Glukose
1	2	0,336	2,0	0	+
2	2	0,379	3,6	0	+
1	3	0,708	1,7	0	+
2	3	0,495	3,3	0	+
1	4	0,960	1,7	0	+
2	4	0,417	3,5	0	-
1	5	0,930	1,7	0	-
2	5	0,467	3,6	0	-
1	6	0,891	1,7	0	-
2	6	0,343	3,7	0	-
1	7	0,781	1,75	0	-
2	7	0,365	3,75	-5,0	-

Zusammenfassend können wir unsere Ergebnisse der Versuche bezüglich des Oxalsäurekonsums durch *Aspergillus niger* folgendermassen ausdrücken:

Aspergillus niger verarbeitet Oxalsäure unabhängig von Zuckermenge in der Kulturlösung und von Mycelalter. Der Verbrauch wird hauptsächlich durch die H-Ionenkonzentration der Mediumflüssigkeit bedingt, d.h. dieser findet nur in der Acidität von geringerem pH-Wert als etwa 3,5 statt. Die günstige Beeinflussung des Mycelwachstums durch Zusatz des organischen Salzes kann schon bemerkt werden, bevor der Verbrauch der entsprechenden Säure beginnt, was der Rolle dieses Salzes als Puffer zu verdanken ist.

Nun fragt es sich, was dieser pH-Grenzwert bedeutet. Das Protoplasma des Pilzes dürfte durch die H-Ionen derart beeinflusst werden, dass der Pilz Oxalsäure nur im kleineren pH als 3,5 verarbeitet. Das muss als die Eigentümlichkeit von *Aspergillus niger* betrachtet werden. Andererseits möchten wir die Zustandsänderung der Oxalsäure in Betracht ziehen, welche zugleich mit der Veränderung der H-Ionenkonzentration rein chemisch auftreten soll. Wenn man die Eigentümlichkeit des Pilzes bezüglich des Oxalsäurekonsums annimmt, muss der Zustand der als brauchbar vorkommenden Oxalsäure deshalb unbedingt gleichzeitig erörtert werden.

Bisher wurden die Nährwerte von organischen Säuren von mehreren Forschern bei verschiedenen Pilzarten vergleichend untersucht, wobei man besondere Aufmerksamkeit auf molekulare Struktur gerichtet. Obwohl die Autoren, welche mit den Untersuchungen über die Pilzkultur mit organischen Säuren sich beschäftigt haben, mitteilten, ob diese als freie Säure oder als deren Salze gegeben wurden, wurden die fortwährende Zustandsänderung solcher Säuren stets ausser Acht gelassen, die im Verlauf des Mycelwachstums durch die Schwankung der Acidität begleitet wird. Die Frage, ob eine organische Säure im undissoziierten Molekularzustand bleibt oder sie in Ionen dissoziiert vorkommt, muss in der Ernährungsstudien des Pilzes ebenso wichtig behandelt werden wie die Vergleichung verschiedener Säurearten.

Wenn eine Lebenserscheinung durch organische Säure beeinflusst wird, müssen sowohl H-Ionen eventuell als undissoziierte Molekülen als die wirksamen Faktoren in Betracht gezogen werden, und dies ist besonders bei den Fettsäuren der Fall. REICHEL (1910) bestätigte, dass die giftige Wirkung der Essigsäure bei der Kultur von *Penicillium* hauptsächlich ihren undissoziierten Molekülen zuzuschreiben ist. In

neuerer Zeit versucht man die Aufnahme der Säure durch die Zellen oder deren Giftigkeit bei verschiedenen pH-Werten teils dadurch quantitativ zu bestimmen, dass der Dissoziationsgrad der Säuren zunächst exakt, z.B. nach den Formeln von MICHAELIS (1922), berechnet wird. Bei der Pilzkultur verwendete BACH (1925) diese Methode bei seinen Untersuchungen über die Giftigkeit von Fettsäuren und Oxalsäure auf das Mycelwachstum von *Aspergillus repens*⁽¹⁾.

Auch beim Erklärungsversuche des Verbrauchs der Oxalsäure durch *Aspergillus niger* muss ihr Dissoziationzustand selbstverständlich in Erwägung gezogen werden, insofern als der Oxalsäurekonsum von H-Ionenkonzentration der Mediumflüssigkeit abhängig ist. Der Dissoziationsgrad α und Dissoziationsrest q der zweibasischen Säure, wie Oxalsäure, kann bei verschiedenen pH-Werten nach den bekannten Formeln von MICHAELIS (1922, S. 48) berechnet und graphisch dargestellt werden (Fig. 2).

$$\alpha_1 = \frac{1}{1 + \frac{h}{k_1} + \frac{k_2}{h}}$$

$$\alpha_2 = \frac{1}{1 + \frac{h}{k_2} + \frac{h^2}{k_1 \cdot k_2}}$$

$$q = \frac{1}{1 + \frac{k_1}{h} + \frac{k_1 \cdot k_2}{h^2}}$$

k_1 und k_2 = Dissoziationskonstanten

h = Wasserstoffionenkonzentration

bei Oxalsäure

$$k_1 = 3,8 \cdot 10^{-2}$$

$$k_2 = 4,9 \cdot 10^{-5}$$

(1) Da findet man eine ausführliche Besprechung der Literatur bezüglich des Verbrauchs der organischen Säuren durch verschiedene Pilzarten (S. 80, 168).

Die Arbeit von RAISTRICK und CLARK (1919), die bezweckt die vergleichenden Untersuchungen der Assimilation der zahlreichen Säurearten und der Oxalsäurebildung angestellt wurde, will ich hier nicht ausführlich zitieren, weil die Arbeitsidee dieser Autoren prinzipiell von der meinigen verschieden ist.

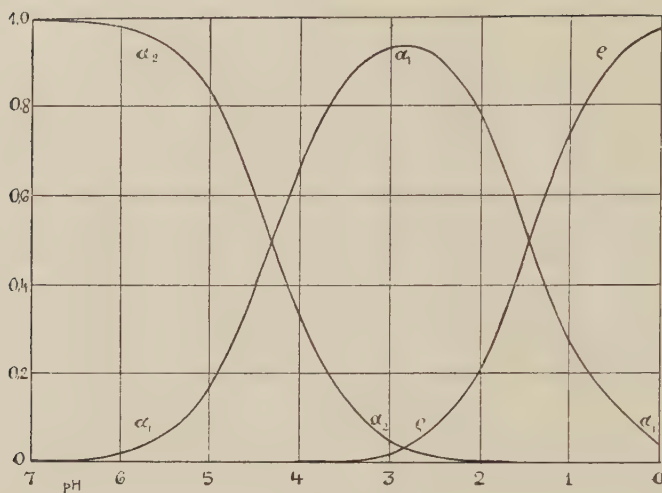


Fig. 2

Am pH 3,5, wo die annähernde Grenze des Verbrauchs der Oxalsäure liegt, findet die zweite Dissoziation sehr schwach statt, während die erste Dissoziation fast das Maximum erreicht.⁽¹⁾ Die Oxalsäure in molekularem Zustande treten in einer messbaren Menge praktisch erst am pH 3,5—3,0 auf und sie vermehrt sich zugleich mit dem Steigen der H-Ionenkonzentration. Dass *Aspergillus niger* in der Kultur mit steigender Acidität plötzlich am pH 3,5 Oxalsäure zu verbrauchen anfängt und dass der Verbrauch stets mit wachsender H-Ionenkonzentration steigt, stimmen gut mit dem Verlauf der Kurve des Dissoziationsrests dieser Säure überein. Es liegt daher nahe zu schliessen, dass *Aspergillus niger* Oxalsäure nur im molekularen Zustande verarbeiten kann, während Mycelalter und Zuckermenge in der Kulturlösung dabei keine Hauptrolle spielen. Die ältere Auffassung, dass organische Säure durch ausreichende Zuckermengen vor ihr Verbrauch geschützt wird, behalten nun ihre Gültigkeit nicht, wenigstens für Oxalsäure bei der Kultur von *Aspergillus niger*.

Es ist natürlich schwer, den Schluss, der aus den Versuchen über die Verarbeitung der Oxalsäure durch *Aspergillus niger* gezogen wurde, auch auf andere Säuren und andere Pilze zu verallgemeinern. Es ist sehr wahrscheinlich, dass solche Beziehung zwischen dem Verbrauch und dem Dissoziationszustand einer organischen Säure je nach dem

(1) α_1 Maximum bei pH=2,87.

Pilz sowie der Säure verschieden sein kann. Acidophiler Pilz, wie *Aspergillus niger*, wäre möglicherweise in der Natur schon sich der Verarbeitung der freien molekularen Oxalsäure angepasst, während acidophobe Pilze dagegen imstande sein dürften, diese lieber im Ionenzustande zu verarbeiten.

Ob auch beim Kulturversuche von *Aspergillus niger* mit Citronensäure als C-Quelle derartige Beziehung besteht, kann man noch nicht entscheiden, weil ich bei Zusatz der Citronensäure oder des Citrats keine exakte Bestimmung dieser Säure ausgeführt habe.⁽¹⁾ Trotzdem ist es aus Versuchen I und II ersichtlich, dass *Aspergillus niger* diese Säure desto besser assimilieren, je höher Acidität der Mediumflüssigkeit ist, und dass der Pilz nur in der Kulturlösung merklich gedeihen, deren pH-Wert weniger als 5,0 beträgt. Dass Citronensäure erst bei pH 5,0 in den molekularen Zustand übergeht, weist einigermassen darauf hin, dass auch bei dieser Säure undissoziierte Moleküle möglicherweise hauptsächlich als brauchbar vorkommen.

Im allgemeinen lässt sich aus der obigen Versuchsergebnissen in diesem Kapitel sagen, dass meine frühere Auffassung der moderierenden Rolle des zugesetzten organischen Salzes weiter bestätigt wurde, während ich den eventuell stattfindenden Verbrauch dieser organischen Säuren natürlich anerkennen will.

Phosphat als Puffer.

In der früheren Arbeit habe ich mitgeteilt, dass Zusatz von Dikaliumphosphat in treffender Dosis auf Mycelwachstum einen günstigen Einfluss in demselben Sinne ausüben, der bei den Versuchen mit den organischen Salzen erwähnt worden ist.

Es dürfte aber gegen diese Auffassung meinerseits Einwände erhoben werden, wonach die genannte Wirkung des Phosphats eher der Zunahme der Phosphorsäure als Nährstoff oder seiner katalytischen Wirkung zuzuschreiben ist.

Dass die Mengenzunahme der Phosphorsäure allein aber nicht das üppige Wachstum verursachen kann, ist aus den folgenden zwei Versuchen ersichtlich.

(1) Obwohl verschiedene Methoden der quantitativen Bestimmung der Citronensäure in einem Gemisch mit anderen organischen Säuren angegeben worden sind, scheinen diese nicht so exakt durchführbar wie bei der Oxalsäurebestimmung.

VERSUCH IX

Kulturlösungen:	(1)	(2)	(3)	(4)
Grundlösung	25	25	25	25
Glukoselösung (m/2)	50	50	50	50
NaH_2PO_4 (m/5)	35	12,5	0	0
Na_2HPO_4 (m/5)	0	12,5	25	0
Umdest. Wasser	0	0	0	25
Summe (ccm)	100	100	100	100
pH	4,2	6,0	6,4	4,2
Glukose in der Kontrolle (ccm KMnO_4)	16,3	16,3	16,3	16,3

TABELLE XI

Kultur	Kulturdauer (Tag)	Pilzgewicht (g)	pH	erzeugte Oxalsäure (ccm n/10)	Glukose (ccm KMnO_4)
1	2	0,198	3,4	0	15,5
2	2	0,182	5,3	Spur	15,2
3	2	0,282	5,7	Spur	14,7
4	2	0,173	3,0	0	15,6
1	3	0,439	2,7	0	13,8
2	3	0,371	3,6	8,0	13,0
3	3	0,313	4,0	12,8	13,0
4	3	0,348	2,5	0	14,3
1	5	1,610	1,9	0	4,7
2	5	1,217	2,5	10,2	7,3
3	5	0,923	2,7	20,6	8,5
4	5	1,063	1,8	0	8,0
1	7	2,003	1,8	0	0,6
2	7	1,545	2,2	14,8	3,2
3	7	1,482	2,4	41,6	3,3
4	7	1,565	1,7	0	2,0

VERSUCH X

Kulturlösungen:	(1)	(2)	(3)	(4)
Grundlösung	25	25	25	25
Glukoselösung (m/2)	50	50	50	50
NaH_2PO_4 (m/5)	25	15	10	0
Na_2HPO_4 (m/5)	0	10	15	25
Summe (ccm)	100	100	100	100
pH	4,2	5,8	6,0	6,4

TABELLE XII

Kultur	Kulturdauer (Tag)	Pilzgewicht (g)	pH	Oxalsäure	Glukose
1	3	0,342	2,7	+	+
2	3	0,371	2,8	++	+
3	3	0,484	2,9	++	+
4	3	0,329	3,6	+++	+
1	5	0,770	2,4	+	+
2	5	1,127	2,4	+	+
3	5	0,934	2,4	++	+
4	5	0,757	2,5	+++	+
1	7	1,257	2,4	+	+
2	7	1,593	2,3	++	+
3	7	1,297	2,3	+++	+
4	7	1,282	2,3	++++	+
1	12	1,488	2,2	+	+
2	12	1,627	2,3	+	Spur
3	12	1,624	2,2	+++	Spur
4	12	1,584	2,4	++++	Spur

Es unterliegt keinem Zweifel mehr, dass die Pufferwirkung der Kulturlösung durch Zusatz von Phosphaten mehr oder weniger vermehrt wird. Trotz solcher Zunahme des Puffervermögens oder in gleicher Konzentration des Phosphats bemerkt man aber den grossen Unterschied des Mycelwachstums unter den verschiedenen Kulturen. Da zwischen dem Mycelwachstum, Pufferwirkung und Oxalsäurebildung, welche letztere in ökonomischer Hinsicht den Pilz sehr benachteiligt, eine sehr komplizierte Beziehung besteht, erzielt *Aspergillus niger* erst dann das beste Wachstum, wenn diese Momente untereinander harmonieren, d.h. wenn der Kulturlösung eine mässig starke Pufferwirkung zukommt (S. 99—100 in meiner früheren Arbeit). Diese Verhältnisse sind besonders bei der Kultur 3, Versuch IX und Kultur 4, Versuch X ersichtlich.

Glukose wird in der Kulturlösung, deren Acidität durch Zusatz des Puffersalzes, wie Phosphat, herabgesetzt ist, bei der Dampfsterilisation karamelisiert. Dass solche Karamelisierung, welche in meiner früheren Arbeit bisweilen stattfand, keine Hauptursache der Wachstumsbeschleunigung ausübt, ist aus den obigen Versuchen begreiflich, wobei die Karamelisierung durch die Einzelsterilisation vermieden wurde. Es muss aber notwendig in dieser Gelegenheit zu entscheiden, wie stark die Karamelisierung des Zuckers auf dessen Nutzbarkeit einwirkt.

VERAUCH XI

Kulturlösungen:	(1)	(2)
Grundlösung	25	25
Glukoselösung (m/2)	50	50
Na ₂ HPO ₄ (m/5)	25	25
Summe (ccm)	100	100
pH	6,38	6,36
Glukose in der Kontrolle (ccm KMnO ₄)	16,5	16,5
Karamelisierung	—	+

TABELLE XIII

Kultur	Kulturdauer (Tag)	Pilzgewicht (g)	pH	erzeugte Oxalsäure (ccm n/10)	Glukose (ccm KMnO ₄)
1	3	0,439	3,81	13,75	12,7
2	3	0,712	2,88	11,25	10,3
1	5	1,175	2,90	25,00	6,7
2	5	1,763	2,34	15,00	2,6
1	6 ^T 6 St	1,260	2,83	25,00	5,5
2	6 ^T 6 St	1,852	2,21	8,65	0,9

Bei der Karamelisierung geschieht das Mycelwachstum üppiger und wird die Oxalsäure viel schwächer gebildet, als bei der Nichtkaramelisierung; woraus sich vermuten lässt, dass beim ersteren Falle die Glukosemoleküle in einen leicht assimilierbaren Zustand umgestaltet werden. Nach der heute vorherrschenden Ansicht⁽¹⁾ entsteht ein Kohlenhydrat-Phosphorsäureester durch eine chemische Verbindung zwischen dem Phosphat, besonders alkalisch reagierenden, und dem Kohlenhydrat, die die chemische Verarbeitung des Kohlenhydrats durch Organismen beeinflussen könnte. In meinem Fall von *Aspergillus niger* dürften solche Entstehung eines Hexosephosphorsäureesters und ihre Beziehung zur Karamelisierung angenommen werden. Trotzdem soll mit einer Möglichkeit solcher spezifischen Hexosephosphorsäureesterbildung die Bedeutung der gleichzeitig wirksamen Pufferwirkung des Dinatriumphosphats aber nicht unterschätzt werden, weil es ausser den alkalischen Phosphaten eine Reihe anderer Salze gibt, die mehr oder weniger starkes Puffervermögen besitzen und in analoger Weise das Mycelwachstum

(1) HARDEN und YOUNG, NEUBERG, MEYERHOF u. a.

beeinflussen.⁽¹⁾

Auch hier ist die Erklärung der Rolle des zugesetzten Phosphats in der Kulturlösung in erster Linie in seiner Pufferwirkung zu suchen.

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(1) Derartige Meinung kann man auch bei anderen Kohlenhydratstoffwechseln ersehen (KOSTYTSCHEW und SCHELUNOW 1912, ABELIN 1926 u. a.)

Glukose wird durch Wasserstoffsuperoxyd bei neutraler Reaktion oxydiert. Dieser Vorgang wird nach W. LOEB durch Phosphat begünstigt, dessen Wirkung tatsächlich auf einer Pufferwirkung beruht, wie HARDEN und HENLEY gezeigt haben. Phosphat kann daher durch beliebige andere Puffer ersetzt werden (cit. nach WARBURG und YABUSOE, 1924 S. 380).

Further Studies on the Ever-Segregating Race in *Portulaca grandiflora*, L., with Special Reference to a Case of Triple Allelomorphism

By Nakae ENOMOTO

(Communication from the Imperial Agricultural Experiment Station, Tokyo.
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In a previous paper⁽¹⁾ I have stated that we have two peculiar white races in *Portulaca grandiflora*, L., viz. the "pseudo-white"⁽²⁾⁽³⁾ and the "special-white."⁽¹⁾ Since 1923 the crossing experiment has been made on these two races to study the genetical relationship existing between them. The results will be reported in this paper.

Distinction between the "Pseudo-white" and the "Special-white"

The pseudo-white and the special-white are entirely identical to each other externally, and they are characterized as follows: leaves and stems are reddish, the corolla is white, though flashed with magenta, especially at its periphery, each petal is generally furnished with a magenta spot at its basal part, filaments, styles and stigmas are all reddish (l.c. IKENO (1921)-119, ENOMOTO (1923)-137). But the two races can easily be distinguished from each other, firstly by the degree of sterility and secondly by the result of self-pollination.

The pseudo-white has been pure-bred by Prof. IKENO for many years and found never to segregate, being thus proved to be genetically homozygous. Through his kindness a number of seeds from 7 plants were delivered to the writer in 1923. In the same year these seeds were sown and 131 plants were raised, all of which proved to belong to the pseudo-white type. Among these plants 5 were taken out as the mother plants for further experiments which were executed during the three succeeding years, 1924 and 1925. The result of selfing, as

(1) N. ENOMOTO: Japanese Journal of Botany **1** (1923): 137-151.

(2) S. IKENO: Journal of College of Agriculture, Imperial University of Tokyo. **8** (1921): 119.

(3) S. IKENO: Japanese Journal of Botany **2** (1924): 54.

we may see in Table I,⁽¹⁾ coincides with the statement of Prof. IKENO that the pseudo-white breeds true in every generation, being genetically homozygous.

The special-white, however, has segregated out in every generation about one-third "normal-whites," which have green leaves and stems, as well as white flowers, showing that it remains always heterozygous. Moreover, it has been observed that in this race sterile seeds as fine as tobacco-powder were produced, besides fully ripened ones, the former amounting to about one quarter of the whole number of seeds produced. This characteristics of the special-white has been explained by the hypothesis that the dominant homozygotes are eliminated as such sterile seeds on account of the lethal action of their component genes (l.c. ENOMOTO). In continuing the selfing of some families of these plants, the same characteristics has also been confirmed, as will be seen below.

In 1923 on 4 plants of the special-white family (SW-A) which were chosen as mother plants for the crossing with the pseudo-white, seeds were obtained by selfing and used for the progeny test in the next year. In this chapter I will describe simply the results of these selfing experiments. In 1924 seeds got by selfing in 1923 were sown, and 512 plants were raised, out of which 297 were the special-white and the remaining 215 the normal-white. In 1925 641 plants were raised from the seeds of the special-white obtained by selfing in 1924: 425 proved to be the special-white, and 216 the normal-white. These results, as indicated in Table II, show that the normal-white was segregated out from every special-white plant in every generation; the percentage of normal-whites was very near to the theoretical ratio 33.33%, except a case of the great deviation in 1924, when the number of families used was rather small.

The degree of sterility of the special-white, as will be seen in Table III, was 29.74% and 26.14% in 1924 and 1925 respectively, both being a little larger than the theoretical 25%. This excess of the number of sterile seeds, as was already discussed in the previous paper, may be attributable to the fact that some seeds corresponding to the zygotes other than the dominant homozygotes, which are destined to die out by lethal action, may also die out, though the degree of sterility is very small. The degree of sterility of the pseudo-white, however, was

(1) For Tables see the end of this paper.

observed to be very slight in comparison with that of the special-white, being 10.48% and 2.18% in 1924 and 1925 respectively, as seen in Table IV.

The Crossing between the Pseudo-white and the Special-white

(A) F_1

The crossing between the pseudo-white and the special-white was made in reciprocal ways in 1923, and the F_1 seeds were sown in 1924. The results of the observation on the F_1 seedlings are given in Table V, which shows that all of the F_1 plants have red stems and leaves without exception, resembling in this respect both parental types closely.

21 plants of the cross ♀ special-white \times ♂ pseudo-white, and 29 of the reciprocal cross were replanted and grown up to perfectly adult condition: they have all shown throughout the whole duration the typical floral characters of the parents, and never displayed any new character. When their seeds were matured, the degree of sterility was tested by an observation of as many capsules as possible left to open-pollination, in order to distinguish roughly between the fertile and the sterile ones. The result shows (Table VI) that, among 50 plants in total 28 were nearly completely fertile, containing very few sterile seeds, while the remaining 22 were partially sterile, containing far more sterile seeds than the former. The ratio of these two types was 28:22, i.e. very near to the ratio 1:1 (D/P.E.=1.25).

The degree of the sterility of these F_1 plants was determined by counting the number of sterile seeds contained in the capsules guarded against the open-pollination. According to the result given in Table VI, the degree of the sterility of the fertile group (*a*) is 6.31% in total, ranging from 0% to 15.82%; while that of the sterile group (*b*) is 27.97% in total, varying from 17.13% to 38.69%. If we compare the degree of sterility of the above two groups of F_1 plants with those of the parental types observed in the same year (Table III & IV), we can see that the fertile group (*a*) and the sterile group (*b*) may well correspond to the pseudo-white and the special-white respectively.

In the F_1 of the cross, pseudo-white \times special-white, therefore, the two parental types may be considered to reappear in the ratio 1:1; I want to remark here that this is only in respect to the degree of the sterility.

(B) F_2

In 1925 the F_2 plants were cultivated from the two groups in F_1 , namely, from those from the fertile plants (a) and those from the sterile ones (b). The results of the observations are given in the following lines.

(1) F_2 from the Fertile Plants (a) in F_1

The F_2 seedlings from the fertile F_1 plants are, as seen in Table VII, composed of the two types, viz. those of which the stems and leaves are red and green respectively. The ratio is 5048 red : 1702 green, that is very near to the ratio 3 : 1, the value of D/P.E. being less than 3 in every family.

Some red-stemmed seedlings in some of these families were cultivated till their adult condition, and the degree of their sterility was tested on the capsules produced by self-pollination. The result in Table VIII shows that all plants were of very low degree of sterility, its percentage being 2.85 in the total average. The low degree of sterility in these plants was also proved by the observation on the capsules left to open-pollination. This characteristics which is associated with the floral characters proves that these plants belong to the pseudo-white type.

The green seedlings have proved themselves to be the normal-white, because their petals were white, pistils, filaments and stamens yellowish green, and the sterility was of very low degree.

The fertile plants (a) in the F_1 of the cross pseudo-white \times special-white segregate in F_2 into the two types of the pseudo-white and the normal-white with the monofactorial Mendelian ratio 3 : 1, the former being dominant over the latter.

(2) F_2 from the Sterile Plants (b) in F_1

All of the F_2 seedlings from the sterile F_1 plants (b) had red stems and leaves, except a few which have green stems and leaves. This exception is not here taken into consideration, as this is perhaps due to the contamination from other families (Table IX). Some of the red seedlings thus raised were taken to grow up to the adult condition, and their sterility was tested by an observation on the capsules left to

open-pollination. It was found that this group of F_2 was composed of the two types, the fertile and the sterile, just as it was the case in F_1 , and their ratio was, as seen in Table X, 86 sterile : 44 fertile, i.e. very near to 2 : 1 ($D/P.E. = 0.19$).

The degree of sterility of both the sterile and the fertile plants in F_2 was also determined by counting the sterile seeds contained in the capsules produced by self-pollination; and it was found that the sterility of the sterile plants was of higher degree, amounting to 25.50% in total, while that of the fertile ones was of far lower degree, being 1.55% in total (Table XI & XII).

When we take the floral characters of plants and also the degree of the sterility into consideration, the sterile plants in F_2 raised from the sterile F_1 plants may be assumed to belong to the special-white, and the fertile sister plants to the pseudo-white. In the F_2 of the sterile F_1 (b), therefore, two parental types, the special-white and the pseudo-white, reappear in a monofactorial Mendelian fashion with the ratio 2 : 1, showing the dominancy of the former over the latter.

Summary of the Experimental Results

The experimental results above described are summarized as follows (Schema, s.p. 287-8) :

(1) The pseudo-white type shows a very slight degree of sterility and always breeds true in each generation, being genetically homozygous (Schema 1).

(2) The special-white type, though similar to the pseudo-white externally, throws out about one quarter sterile seeds and one-third normal-whites, being genetically always heterozygous (Schema 2).

(3) The F_1 generation of the cross between the pseudo-white and the special-white is composed of the two parental types, namely, the fertile or the pseudo-white and the sterile or the special-white, and does never produce any new type. The ratio of these two types is very near to 1 : 1 (Schema 3).

(4) The F_2 generation of the F_1 pseudo-white segregates into the pseudo-white and the normal-white in the ratio 3 : 1, the former being dominant over the latter (Schema 3).

(5) The F_2 generation of the F_1 special-white, however, segregates into the two types, viz. the special-white which produces about one

quarter sterile seeds and the pseudo-white which is nearly completely fertile. The segregation ratio is 2:1, i.e. based upon a single factor difference, the special white being dominant over the pseudo-white (Schema 3).

Genetical Explanation

Triple Allelomorphism among the Pseudo-white, the Special-white and the Normal-white

In the foregoing experiment, if we consider the relation of the dominancy among the three types, viz. the pseudo-white, the special-white and then the normal-white, we can easily see that that of the triple allelomorphism exists among them: both the special-white and the pseudo-white are dominant over the normal-white, while the special-white is dominant over the pseudo-white, there being a single factor difference between each of them. These relations may well be explained as follows:

(1) *Pseudo-white*: Prof. IKENO determined the genetical formula of the pseudo-white as CCP_sP_s , where C is the fundamental factor for producing any colour, cc plant being white; C alone, either in one or double dose, makes flower orange (l.c. IKENO 1921); P_s in double dose, accompanied by C (either in one or double dose) gives the characteristics of the pseudo-white, the orange colour caused by the factor C being suppressed, so that CCP_sP_s is constant pseudo-white, CcP_sP_s heterozygous pseudo-white, and ccP_sP_s , $ccP_s p_s$ as well as $ccp_s p_s$ are all white (l.c. IKENO 1924).

(2) *Special-white*: The writer gave the formula Aa for the special-white and aa for the normal-white, the zygote AA appears as sterile seeds on account of the lethal action of the factor A in double dose (l.c. ENOMOTO). In applying here the genetical formula of the pseudo-white above described, the genetical formula of the special-white may be assumed in either of the two following ways: (a) $C'c'P_sP_s$, where C' is a modified factor of C and acts lethal in double dose. (b) $\widehat{CL}\widehat{cl}P_sP_s$, where L is a factor which acts lethal in double dose and is always completely linked with C , $\widehat{CL}\widehat{CL}$ zygote being thus unable to survive. The alternative (b) will be used here at first for the explanation of the results of the crossing between the pseudo-white and the special-white.

(3) The cross of the pseudo-white \times special-white may, according to the alternative (b), be written as follows: ⁽¹⁾

Parents = $\widehat{Cl}\widehat{Cl}$ (pseudo-white) \times $\widehat{CL}\widehat{cl}$ (special-white); $F_1 = 1 \widehat{Cl}\widehat{cl} : 1 \widehat{CL}\widehat{Cl} = 1$ pseudo-white : 1 special-white; F_2 from the F_1 pseudo-white = $1 \widehat{Cl}\widehat{Cl} : 2 \widehat{Cl}\widehat{cl} : 1 \widehat{cl}\widehat{cl} = 3$ pseudo-white : 1 normal-white; F_2 from the F_1 special-white = $1 \widehat{CL}\widehat{CL} : 2 \widehat{CL}\widehat{Cl} : 1 \widehat{Cl}\widehat{Cl} = 1$ sterile seeds : 2 special-white : 1 pseudo-white. The above consideration will clearly explain the results of the crossing between the pseudo-white and the special-white.

The triple allelomorphism among the pseudo-white, the special-white and the normal-white is due to the relation among the three compound factors, \widehat{CL} , \widehat{Cl} and \widehat{cl} , any two of them being able to make an allelomorphic pair.

In the above explanation it was assumed that the factor C responsible for any colour formation was completely linked with a special factor L , which acts lethal in double dose. But these two linked factors \widehat{CL} may be also assumed to be a single factor, called C' which is not only responsible for the colour formation but also for the lethal action when present in double dose. The factors \widehat{Cl} and \widehat{cl} , then, may be represented simply by C and c respectively. Consequently the triple allelomorphism among \widehat{CL} , \widehat{Cl} and \widehat{cl} may be also considered as that among the three factors C' , C and c . This simple assumption will hold true in so far as any cross-over does never occur among the offspring of the cross between the pseudowhite and the special-white, which is really the case in the present experiment.

The Origin of the Special-white

The present experiment has shown that the lethal action possessed by the special-white is associated with a fundamental factor responsible for the formation of the colour in the plant, and may be inheritable as a single factor. This lethal action may be connected naturally with any type of *Portulaca grandiflora*, which has coloured flowers, such as magenta-type, orange-type, red-type etc. reported by Prof. IKENO, whenever C changes to C' , so that the existence of the lethal action will not be necessarily confined to the special-white type. From this fact, it

(1) In the following lines the letters P_s P_s are omitted in the genetical formulae for the simplicity's sake.

is not clear, therefore, whether the special-white plant had already the lethal action when it was found by the writer for the first time in 1918; and also it is not certain whether or not the lethal action has taken its origin in the orange-type which was mated with the special-white. At all events, if we consider the rareness of the existence of the factor C' , the latter might perhaps be considered to have originated in past time by the dominant mutation $C \rightarrow C'$ or $c \rightarrow C'$. If this assumption may be granted, the occurrence of the special-white in *Portulaca* closely resembles that of the ever-segregating "no-lunule" type⁽¹⁾ in the silk-worm, the origin of which was attributed to the dominant mutation from the recessive normal-type.

In conclusion the writer wishes to express his sincerest thanks for the kindness of Prof. IKENO, who gave the material of this experiment and looked over this manuscript.

(1) Y. TANAKA: "No-lunule," lethal factor in the silk-worm. Jour. Dep. Agric., Kyushu Imp. Univ. **1** (1924): 210-242.

TABLE I. *The Result of the Selfing of the Pseudo-white*

Year	Family No.	Plant No. in preceeding year	Number of plants	Type
1923	PS-1	—	17	Pseudo-white
	„ -2	—	23	„
	„ -3	—	7	„
	„ -4	—	12	„
	„ -5	—	9	„
	„ -6	—	38	„
	„ -7	—	25	„
Total			131	„
1924	PS-1	PS-2- 1	21	„
	„ -2	„ 5- 1	52	„
	„ -3	„ 5- 4	18	„
	„ -4	„ 6- 1	38	„
	„ -5	„ 6- 3	59	„
Total			188	„
1925	PS-1	PS-5- 6	166	„
	„ -2	„ „- 7	93	„
	„ -3	„ „- 8	21	„
	„ -4	„ „- 9	93	„
	„ -5	„ „-10	53	„
Total			426	„

TABLE II. *The Result of the Selfing of the Special-white*

Year	Family No.	Plant No. in preceeding year	Special white	Normal white	Total	Normal white (%)	D. as 1/3 (%)	P. E. (%) (±)	D/P. E.
1923	SW-A	SWR-1-24	73	36	109	33.03	- 0.30	3.06	0.98
1924	SW-1	SW-A-40	67	54	121	44.63	+11.30	2.89	3.91
	„ 2	„ 47	61	27	88	30.68	- 2.65	3.39	0.78
	„ 3	„ 57	64	43	107	40.19	+ 6.86	3.07	2.23
	„ 4	„ 73	105	91	196	46.43	+13.10	2.27	5.77
Total			297	215	512	41.99	+ 8.66	1.41	6.16
1925	SW-1	SW-1-1	128	69	197	35.03	+ 1.70	2.27	0.75
	„ 2	„ 2	86	37	123	30.08	- 3.25	2.87	1.13
	„ 3	„ 3	43	22	65	33.85	+ 0.52	3.94	0.13
	„ 4	„ 4	64	31	95	33.63	- 0.70	3.26	0.22
	„ 5	„ 5	104	57	161	35.40	+ 2.07	2.51	0.83
Total			425	216	641	33.70	+ 0.37	1.26	0.30

TABLE III. *The Sterility of the Special-white*

Year	Family No.	Plant No.	Flower No.	Number of Seeds		Total	Sterility %
				Fertile	Sterile		
1924	SW-1	1	1	78	55	133	25.30
	"	1	2	113	21	134	
	"	1	3	119	29	148	
	"		total	310	105	415	
	"	2	1	70	58	128	32.31
	"	2	2	132	51	183	
	"	2	3	106	38	144	
	"		total	308	147	455	
	"	3	1	152	49	201	34.36
	"	3	2	83	74	157	
	"		total	235	123	358	
	"	4	1	118	56	174	
	"	4	2	119	35	154	26.51
	"	4	3	104	32	136	
	"		total	341	123	464	
	"	5	1	123	35	158	
	"	5	2	116	59	175	30.75
	"	5	3	119	65	184	
	"		total	353	169	517	
Total				1552	657	2209	29.74
1925	SW-1-1	1	1	47	18	65	21.15
	"	1	2	35	4	39	
	"		total	82	22	104	
	"	2	1	72	47	119	
	"	2	2	53	16	69	32.00
	"	2	3	62	21	83	
	"	2	4	72	29	101	
	"	2	5	49	32	81	
	"		total	308	145	453	18.63
	"	3	1	100	26	126	
	"	3	2	106	26	132	
	"	3	3	126	24	150	
	"		total	332	76	408	30.41
	"	5	1	72	24	96	
	"	5	2	79	42	121	
	"		total	151	66	217	
Total				873	309	1182	26.14

TABLE IV. *The Sterility of the Pseudo-white*

Year	Family No.	Plant No.	Flower No.	Number of Seeds		Total	Sterility %
				Fertile	Sterile		
1924	PS -5	6	1	138	24	162	7.77
		6	2	162	3	165	
		6	3	56	3	59	
			total	356	30	386	
		7	1	167	6	173	7.27
		7	2	135	22	157	
		7	3	55	0	55	
			total	357	28	385	
		8	1	89	14	103	11.76
		8	2	79	4	83	
		8	3	57	12	69	
			total	225	30	255	
		9	1	105	10	115	11.44
		9	2	73	13	86	
			total	178	23	201	
		10	1	134	57	191	
		10	2	92	4	96	13.94
		10	3	206	9	215	
			total	432	70	502	
		Total		1548	181	1729	10.48
1925	PS-5-6	6	1	98	0	98	2.92
		6	2	35	4	39	
			total	133	4	137	
		7	1	58	2	60	0.97
		7	2	146	0	146	
			total	204	2	206	
		8	1	47	0	47	3.66
		8	2	32	3	35	
			total	79	3	82	
		Total		416	9	425	2.18

TABLE V. *F₁ Seedlings of the Cross Pseudo-white × Special-white*

Cross No.	Parent		Number of Seedlings	Type Colour of Stems and leaves
	Male	Female		
Cr.- 1	SW-A-40	PS-5-1	25	Red
„ 2	„ 40	„ 4-2	34	„
„ 3	„ 40	„ 4-2	40	„
„ 4	„ 56	„ 5-4	45	„
„ 5	„ 58	„ 4-3	28	„
„ 6	„ 56	„ 5-4	27	„
„ 7	„ 57	„ 6-3	12	„
„ 8	„ 57	„ 6-3	63	„
„ 9	„ 40	„ 6-3	22	„
„ 10	„ 60	„ 6-3	39	„
„ 11	„ 73	„ 7-3	50	„
Total			385	„
Cr.-12	PS-7-3	SW-A-73	28	Red
„ 13	„ 5-1	„ 46	15	„
„ 14	„ 7-3	„ 73	22	„
„ 15	„ 5-1	„ 46	28	„
„ 16	„ 6-3	„ 57	39	„
„ 17	„ 2-1	„ 47	17	„
„ 18	„ 6-3	„ 40	63	„
„ 19	„ 2-1	„ 47	10	„
„ 20	„ 5-1	„ 46	37	„
„ 21	„ 7-3	„ 73	27	„
„ 22	„ 4-2	„ 85	49	„
„ 23	„ 4-2	„ 73	8	„
Total			343	„

TABLE VI. A. *The Sterility of the F₁ Plants—(a) Fertile Plants*

Parent	Cross No.	Plant No.	No. of Capsules tested	Number of Seeds			Sterility %
				Fertile	Sterile	Total	
♀ Special-white × ♂ Pseudo-white	Cr.-9	8	3	450	5	455	1.10
	"	19	2	341	6	347	1.73
	"	5	2	365	14	379	3.69
	"	13	3	537	26	563	4.62
	"	16	2	384	23	407	5.65
	"	17	3	597	37	634	5.84
	"	2	3	462	38	500	7.60
	"	10	2	206	19	225	8.44
	"	4	3	477	46	523	8.80
	"	6	3	429	54	483	11.18
	"	18	3	405	55	460	11.96
	"	14	2	207	39	246	15.82
Total				4860	362	5222	6.93
♀ Pseudo-white × ♂ Special-white	Cr.-18	5	3	564	0	564	0.00
	"	9	3	587	4	591	0.68
	"	10	3	537	6	543	1.10
	"	8	3	630	8	638	1.25
	"	18	2	304	6	310	1.94
	"	25	2	432	15	447	3.36
	"	4	3	434	22	456	4.82
	"	13	3	520	27	547	4.94
	"	22	3	497	26	523	4.97
	"	15	3	593	44	637	6.91
	"	21	3	644	59	703	8.39
	"	16	3	492	53	545	9.72
	"	26	3	371	45	416	10.82
	"	2	3	364	49	413	11.86
	"	12	3	480	65	545	11.93
	"	11	3	503	72	575	12.52
Total				7952	501	8453	5.93
Grand total				12812	863	13675	6.31

TABLE VI. B. *The Sterility of F₁ Plants—(b) Sterile Plants*

Parent	Cross No.	Plant No.	No. of Capsules tested	Number of Seeds			Sterility %
				Fertile	Sterile	Total	
♀ Special-white X ♂ Pseudo-white	Cr.-3	21	3	369	116	485	23.92
	„	12	3	292	104	396	26.26
	„	1	2	246	89	335	26.57
	„	9	3	431	173	604	28.64
	„	15	3	391	173	564	30.67
	„	7	3	394	180	574	31.36
	„	3	3	343	163	506	32.21
	„	20	3	387	190	577	32.93
	„	11	3	328	207	535	38.69
Total				3181	1395	4576	30.49
♀ Pseudo-white X ♂ Special-white	Cr.-18	1	2	208	43	251	17.13
	„	6	3	180	40	220	18.18
	„	29	3	484	128	612	20.92
	„	28	3	394	107	501	21.36
	„	20	3	373	113	486	23.25
	„	24	3	274	88	362	24.31
	„	3	3	307	107	414	25.85
	„	7	3	442	160	602	26.58
	„	31	3	291	110	401	27.43
	„	19	3	384	151	535	28.22
	„	14	3	332	167	499	33.47
	„	17	3	207	113	320	35.31
	„	27	3	388	158	546	28.94
Total				4264	1485	5749	25.83
Grand total				7445	2880	10325	27.97

TABLE VII. *The F₂ Seedlings from the Fertile Plants (a) in F₁*

Family No.	Number of Plants			Green %	Dev. 3:1 %	P. E. (±)	D/P. E
	Red	Green	Total				
Cr.-9-2	174	58	232	25.00	±0.00	1.92	0.00
14	105	35	140	25.00	±0.00	2.47	0.00
18	158	52	210	24.77	-0.23	2.02	0.11
8	227	77	304	25.33	+0.33	1.68	0.20
4	184	63	247	25.51	+0.51	1.86	0.27
19	176	57	233	24.47	-0.53	1.91	0.28
17	196	63	259	24.32	-0.68	1.82	0.38
5	122	37	159	24.27	-1.73	2.32	0.75
10	98	28	126	22.22	-2.78	2.63	1.06
16	127	50	177	28.25	+3.25	2.20	1.48
6	206	57	263	21.67	-3.33	1.80	1.79
13	237	81	318	25.48	+0.48	1.64	0.29
Total	2010	658	2668	24.66	0.34	0.57	0.60
Cr.-18-18	95	31	126	24.60	-0.40	2.60	0.16
15	234	76	310	24.52	-0.48	1.66	0.29
10	200	64	264	24.24	-0.76	1.80	0.42
26	190	60	250	24.00	-1.00	1.85	0.54
11	183	65	248	26.21	+1.21	1.85	0.65
21	191	68	259	26.26	+1.26	1.82	0.69
25	245	87	332	26.21	+1.21	1.60	0.76
2	169	61	230	26.52	+1.52	1.93	0.79
9	230	86	316	27.22	+2.22	1.64	1.35
8	213	60	273	21.98	-3.02	1.77	1.71
16	220	62	282	21.99	-3.01	1.74	1.73
22	240	68	308	22.08	-2.92	1.66	1.76
5	191	75	266	28.20	+3.20	1.79	1.79
4	210	86	296	29.05	+4.05	1.64	2.47
23	227	95	322	29.50	+4.50	1.63	2.76
Total	3038	1044	4082	25.58	+0.58	0.46	1.26
G. total	5048	1702	6750	25.22	+0.22	0.36	0.61

TABLE VIII. *The Sterility of the F₂ Plants from the Fertile Plants (a) in F₁*

Family No.	Plant No.	No. of Capsules tested	Number of Seeds			Sterility %
			Fertile	Sterile	Total	
Cr.-9-4	2	1	17	0	17	0.00
"	5	1	86	0	86	0.00
"	13	2	41	0	41	0.00
"	15	1	109	0	109	0.00
"	20	2	97	0	97	0.00
"	21	2	179	0	179	0.00
"	27	7	80	0	80	0.00
"	24	1	79	1	80	1.25
"	26	1	41	2	43	4.65
"	8	2	81	7	88	7.95
"	16	1	57	11	68	16.18
Total			867	21	888	2.36
Cr.-9-6	3	2	195	0	195	0.00
"	6	2	169	0	169	0.00
"	28	1	86	0	86	0.00
"	31	2	143	0	143	0.00
"	27	1	90	2	92	2.17
"	25	1	153	4	157	2.55
"	30	1	146	4	150	2.67
"	53	2	204	8	212	3.77
"	54	1	49	2	51	3.92
"	32	3	459	33	492	6.71
Total			1694	53	1747	3.03
Cr.-9-10	7	1	28	0	28	0.00
"	9	1	21	0	21	0.00
"	30	2	127	0	127	0.00
"	31	2	125	0	125	0.00
"	35	2	213	1	214	0.47
"	29	2	157	1	158	0.63
"	27	1	94	3	97	3.09
"	33	2	298	16	314	5.10
"	32	1	50	14	64	21.88
Total			1113	35	1148	3.05
Cr.-18-10	20	1	107	0	107	0.00
"	36	1	117	0	117	0.00
"	39	1	89	0	89	0.00
"	56	1	78	0	78	0.00
"	69	2	219	0	219	0.00
"	43	2	182	4	186	2.15
"	38	1	112	6	118	5.09
"	57	1	107	7	114	6.14
"	12	2	76	5	81	6.17
Total			1087	22	1109	1.98

TABLE VIII (Continued)

Family No.	Plant No.	No. of Capsules tested	Number of Seeds			Sterility %
			Fertile	Sterile	Total	
Cr.-18-11	25	2	140	1	141	0.71
"	10	2	208	2	210	0.95
"	13	3	217	4	221	1.81
"	7	3	365	29	394	7.36
Total			930	36	966	3.73
Grand total			5691	167	5858	2.85

TABLE IX. The F_2 Seedlings from the Sterile Plants (b) in F_1

Family No.	Number of Plants			Green %
	Red type	Green type	Total	
Cr.-9- 1	129	0	129	0.00
3	143	0	143	0.00
7	119	2	121	1.65
9	213	0	213	0.00
11	139	0	139	0.00
12	92	0	92	0.00
15	188	0	188	0.00
20	239	0	239	0.00
21	264	0	264	0.00
Total	1526	2	1528	0.13
Cr.-18- 1	90	0	90	0.00
3	162	2	164	1.22
6	62	0	62	0.00
7	164	1	165	0.61
14	148	0	148	0.00
17	45	0	45	0.00
19	104	3	107	2.80
20	165	0	165	0.00
24	163	0	163	0.00
27	170	0	170	0.00
28	211	0	211	0.00
29	163	0	163	0.00
31	37	0	37	0.00
Total	1684	6	1690	0.36
Grand total	3210	8	3218	0.25

TABLE X. *F₂ Adult Plants from the Sterile Plants (b) in F₁*

Family No.	Number of Plants			Fertile Plants %	Dev. as 33 33%	P. E. %	D/P.E.
	Sterile	Fertile	Total				
Cr.- 9- 1	41	20	61	32.79	0.54	4.68	0.12
„ 7	32	18	50	36.00	2.67	4.49	0.59
Cr.-18-14	2	1	3	33.33	0.00	—	0.00
„ „ 20	11	5	16	31.25	2.08	7.93	0.26
Total	86	44	130	33.85	0.52	2.78	0.19

TABLE XI. *The Sterility of the Sterile F₂ Plants from the Sterile Plants (b) in F₁*

Family No.	Plant No.	No. of Capsules tested	Number of Seeds			Sterility %
			Fertile	Sterile	Total	
Cr.- 9- 1	4	1	36	13	49	26.53
„	5	2	100	40	140	28.57
„	7	2	42	15	57	26.32
„	9	3	198	56	254	22.05
„	11	2	78	25	103	24.27
„	12	1	65	26	91	28.57
„	16	2	94	26	120	21.67
„	17	2	115	58	173	33.53
„	21	2	109	35	144	24.31
„	22	1	46	29	75	38.67
„	27	1	12	5	17	29.41
„	28	3	198	37	235	15.74
„	31	3	160	47	207	22.71
„	32	1	26	10	36	27.78
„	33	3	195	56	251	22.31
„	34	3	117	49	166	29.52
„	35	2	81	40	121	33.06
„	39	3	162	60	222	27.03
„	40	1	43	11	54	20.37
„	42	2	43	14	57	24.56
„	45	1	35	6	41	14.63
„	49	1	30	12	42	28.57

TABLE XI (Continued)

Family No.	Plant No.	No. of Capsules tested	Number of Seeds			Sterility %
			Fertile	Sterile	Total	
Cr.- 9- 1	51	1	33	8	41	19.51
„	55	2	92	30	122	24.59
Cr - 9- 7	58	2	102	38	140	27.14
„	1	1	31	10	41	24.39
„	4	2	66	20	86	23.26
„	10	1	26	8	34	23.53
„	11	1	96	31	127	24.41
„	14	1	30	8	38	21.05
„	15	1	35	16	51	31.37
„	18	2	199	66	265	24.91
„	20	1	40	9	49	18.37
„	22	2	75	31	106	29.25
„	24	2	132	39	171	22.81
„	30	1	22	4	26	15.38
„	34	1	45	16	61	26.23
„	36	2	75	30	105	28.57
„	37	1	30	12	42	28.57
„	38	2	106	30	136	22.06
„	40	1	19	7	26	26.92
„	44	1	51	18	69	26.09
„	44	1	30	8	38	21.05
„	45	2	111	50	161	31.06
„	49	3	191	64	255	25.10
„	50	1	113	31	144	21.53
Cr.-18-10	1	1	39	14	53	26.42
„	3	2	178	68	246	27.64
Cr.-18-11	1	1	37	10	47	21.28
„	2	1	83	33	116	28.45
„	8	3	159	38	197	19.29
„	11	1	20	12	32	37.50
„	13	2	69	31	100	31.00
„	14	1	41	14	55	25.45
„	15	3	125	51	176	28.98
„	18	1	58	30	88	34.09
Total			4544	1555	6099	25.50

TABLE XII. *The Sterility of the Fertile F_2 Plants from the Sterile Plants (b) in F_1*

Family No.	Plant No.	No. of Capsules tested	Number of Seeds			Sterility %
			Fertile	Sterile	Total	
Cr.- 9- 1	1	3	294	2	296	0.68
	2	2	180	1	181	0.55
	3	3	145	2	147	1.36
	6	2	152	3	155	1.92
	8	1	89	3	92	3.26
	19	1	28	1	29	3.45
	23	2	163	4	167	2.40
	25	2	166	3	169	1.78
	29	1	22	0	22	0.00
	30	2	108	3	111	2.73
	36	1	108	0	108	0.00
	37	1	82	0	82	0.00
	38	1	84	1	85	1.18
	41	2	80	1	81	1.23
	48	2	213	4	217	1.85
Cr.- 9- 7	2	1	28	0	28	0.00
	5	2	168	1	169	0.57
	8	2	652	1	653	0.15
	9	1	16	0	16	0.00
	12	2	313	11	324	0.34
	13	1	65	0	65	0.00
	16	2	118	3	121	2.48
	17	1	120	3	123	2.44
	19	1	109	1	110	0.91
	25	1	100	3	103	2.91
	27	2	133	6	139	4.32
	28	3	265	5	270	1.85
	29	1	160	4	164	2.44
	31	2	99	0	99	0.00
	43	1	12	0	12	0.00
Cr.-18-14	47	1	57	0	57	0.00
	48	1	85	0	85	0.00
Cr.-18-20	2	1	15	0	15	0.00
	4	1	46	2	48	4.17
	7	2	69	0	69	0.00
	12	1	80	3	83	3.61
	16	1	78	3	81	3.70
Total			4702	74	4776	1.55

Schema of the Experimental Results

Remarks: P.W.=Pseudo-white, S.W.=Special-white, N.W.=Normal-white, F.S.=Fertile seeds, S.S.=Sterile seeds, Ex=Experimental number, Theo=Theoretical number, D=Deviation, P.E.=Probable error

		(1) Selfing of the P.W.		(2) Selfing of the S.W.	
Year		P.W.		S.W.	
1923	Ex	..... = 100%	.....	..... = 66.97%	
	Theo	..... = 100	.....	..... = 66.67	
	D	..... = 0	.....	..... = +0.30	
	D/P.E.	..... = 0	.....	..... = 0.98	
		↓		↓	↓
		P.W.		S.W.	N.W.
1924	Ex	..... = 100%	.....	..... = 58.01%	..... = 41.99%
	Theo	..... = 100	.....	..... = 66.67	..... = 33.33
	D	..... = 0	.....	..... = 8.66	
	D/P.E.	..... = 0	.....	..... = 6.16	
		↓	↓	↓	↓
		F.S.	S.S.	F.S.	S.S.
1925	Ex	..... = 89.53%	..... = 10.47%	..... = 70.26%	..... = 29.74%
	Theo	..... = 100-x	..... = x	..... = 75.00-y	..... = 25.00+y
		↓		↓	↓
		P.W.		S.W.	N.W.
1925	Ex	..... = 100%	.....	..... = 66.30%	..... = 33.70%
	Theo	..... = 100	.....	..... = 66.67	..... = 33.33
	D	..... = 0	.....	..... = -0.37	
	D/P.E.	..... = 0	.....	..... = 0.29	
		↓	↓	↓	↓
		F.S.	S.S.	F.S.	S.S.
1925	Ex	..... = 97.84%	..... = 2.18%	..... = 73.86%	..... = 26.14%
	Theo	..... = 100-x	..... = x	..... = 75.00-y	..... = 25.00+y

(3) The Cross of P.W. \times S.W.

		P.W. \times S.W.			
		P.W.		S.W.	
F ₁ (1924)	Ex.....	= 56.00%		= 44.00%	
	Theo.....	= 50.00		= 50.00	
	D.....	= +6.00		= -6.00	
	D/P.E.....	= 1.25			
		F.S. S.S.		F.S. S.S.	
F ₁ (1924)	Ex.....	= 93.69% = 6.31%		= 72.03% = 27.97%	
	Theo.....	= 100-x = x		= 75.00-y = 25.00+y	
		P.W. N.W.		S.W. P.W.	
F ₁ (1925)	Ex.....	= 74.78% = 25.22%		= 66.15% = 33.85%	
	Theo.....	= 75.00 = 25.00		= 66.67 = 33.33	
	D.....	= -0.22 = +0.22		= -0.52 = +0.52	
	D/P.E.....	= 0.61		= 0.19	
		F.S. S.S.		F.S. S.S.	
F ₁ (1925)	Ex... ..	= 97.15% = 2.85%		= 74.50% = 25.50%	
	Theo.....	= 100-x = x		= 75.00-y = y	
				= 98.45% = 1.55%	
				= 100-x = x	

A Contribution to the Knowledge of the Melampsoraceae of Hokkaidô

By Naohide HIRATSUKA

(Received September 9, 1927)

In 1896, Dr. NAOHARU HIRATSUKA, my father, described fourteen Japanese species of the Melampsoraceae in his graduation thesis, and out of which he⁽¹⁾ reported later eight species under the title of "Notes on some Melampsorae of Japan." Among them, the following five species were recorded from Hokkaidô; viz. *Melampsora Alni* THÜM. (= *Melampsoridium Hiratsukanum* ITÔ) on *Alnus incana* WILLD. var. *glauca* AIT. (= *A. hirsuta* TURCZ.), *Pucciniastrum Agrimoniae* (DC.) HIRATSUKA (= *P. Agrimoniae* (DIET.) TRANZSCH.) on *Agrimonia pilosa* LEDEB., *Pucciniastrum Tiliae* MIYABE on *Tilia cordata* MILL. var. *japonica* MIQ. (= *T. japonica* SIMK.) and *T. Miqueliana* MAXIM. (= *T. Maximowicziana* SHIRASAWA), *Pucciniastrum Styracinum* HIRATSUKA on *Styrax Obassia* SIEB. et ZUCC. and *Pucciniastrum Miyabeianum* HIRATSUKA on *Viburnum furcatum* BL. Out of them four species were described in these papers as new by him.

In 1913, H. & P. SYDOW⁽²⁾ reported a large number of fungi in the northern part of Japan collected by M. MIURA, among them four species of the Melampsoraceae new to Hokkaidô were included. They are *Melampsorella Caryophyllacearum* SCHRÖT., *Melampsora Kusanoi* DIET., *Uredinopsis Struthiopteridis* STÖRM. and *Milesina Scolopendrii* JAAP. In 1915, Dr. K. MIYABE⁽³⁾ reported that *Chrysomyxa* on *Rhododendron brachycarpum* D. DON. and *Rh. chrysanthum* PALL. are identical to *Chrysomyxa expansa* DIET. and that its aecidial stage is *Peridermium Piceae-hondoensis* DIET. Dr. T. MATSUMOTO studied the life history of *Melampsora* parasitic on some species of *Salix* growing in the vicinity of Sapporo, and in 1915, he⁽⁴⁾ reported that three species are new to science and two new to the mycological flora of our country.

(1) Bot. Mag. Tokyo, XI, p. 45-49, 1897; XII, p. 30-34, 1898; XIV, p. 89-93, 1900.

(2) Ann. Myc. XI, p. 93-118, 1913.

(3) Bot. Mag. Tokyo, XXIX, p. 258-165, 1915.

(4) Transact. Sapporo Nat. Hist. Soc. VII, p. 22-37, 1915.

They are *Melampsora yezoensis* MIYABE et MATSUMOTO, *M. Larici-Miyabeana* MIYABE et MATSUMOTO, *M. Larici-opaca* MIYABE et MATSUMOTO, *M. Larici-epitea* KLEB. and *M. Larici-daphnoidis* KLEB.

Recently, the writer⁽¹⁾ described twenty-two species of the Japanese Melampsoraceae among which twenty species are recorded from Hokkaidô. In the same year, he⁽²⁾ also newly added one species, *Thekopsora guttata* (SCHRÖT.), SYD. to the list of the Japanese Melampsoraceae in his paper, "Uredinales collected in the vicinity of Lake Akan, Hokkaidô."

The materials used by the writer in this study include besides the specimens collected by my father some thirty years ago and also my own collections from different places of Hokkaidô, the rich collection of the group preserved in the Herbarium of the Faculty of Agriculture, Hokkaidô Imperial University, Sapporo. The total number of the specimens which the writer examined amounts to more than one thousand, in which thirteen genera and fifty-eight species are included as follows:—

<i>Melampsora</i>	10 species	<i>Chnoopsora</i>	1 species
<i>Phakopsora</i>	1 „	<i>Melampsorella</i> . . .	1 „
<i>Melampsoridium</i> .	5 „	<i>Pucciniastrum</i> . . .	11 „
<i>Thekopsora</i>	9 „	<i>Calyptospora</i> . . .	1 „
<i>Uredinopsis</i>	4 „	<i>Milesina</i>	1 „
<i>Hyalopsora</i>	2 „	<i>Chrysomyxa</i> . . .	9 „
<i>Cronartium</i>	3 „		
<hr/>			
Total		58 species.	

Among the fifty-eight species, two species are ascertained to be new to science and four species new to the mycological flora of Japan. Species new to science are *Chnoopsora Itôana* HIRATSUKA and *Phakopsora Artemisiae* HIRATSUKA. Species new to Japan are *Melampsora Euphorbiae* (SCHUB.) CAST., *Hyalopsora Polypodii* (DIET.) P. MAGN., *Uredinopsis Adianti* KOM. and *Chrysomyxa Ramischiae* LAGERH.

I wish here to express my heartiest thanks to Profs. K. MIYABE and S. ITÔ for their help and valuable advice, to Dr. Y. TOCHINAI for his constant encouragement and also to Prof. K. TOGASHI and

(1) Jour. Facul. Agric. Hokkaidô Imp. Univ. XXI, p. 1—41, 1927.

(2) Transact. Sapporo Nat. Hist. Soc. IX, p. 225, 1927.

Miss Y. HOMMA for their kindness in furnishing me many valuable specimens.

FAM. MELAMPSORACEAE

SUBFAM. I. MELAMPSOREAE

Melampsora CAST.

1. *Melampsora Hypericorum* SCHRÖTER in Brand- u. Rostpilze Schles. p. 26, 1869; Pilze Schles. I, p. 363, 1884—BUBÁK, Rostpilze Böhmens, p. 209, 1908—FISCH. Ured. Schw. p. 506, fig. 317, 1904—LIRO, Ured. Fenn. p. 559, 1908—SACC. Syll. VII, p. 591—TROTT. Fl. Ital. Crypt. Ured. p. 399, 1914. (HIRATS. in Transact. Sapporo Nat. Hist. Soc. IX, p. 234, 1927).

SYN. *Mesopsora Hypericorum* DIET. in Ann. Myc. XX, p. 29, 1922. (TOGASHI in Jap. Jour. Bot. II, p. 83, 1924—TOGASHI & HIRATS. in Jour. Soc. Agric. & Forestr. Sapporo, XVI, p. 75, 1924.)

HAB. On leaves and stems of *Hypericum erectum* THUNB. (*Otogirisô*).

Prov. Shiribeshi:—Niki-mura (Aug. 1, 1923, m.). Prov. Ishikari:—Mt. Teine (Sept. 2, 1924, m.); Sôunbetsu (Aug. 3, 1925, m.). Prov. Kitami:—Noshappusaki (Oct. 15, 1923, m.); Momoiwa (Rebun) (Aug. 9, 1922, K. TOGASHI). Prov. Kushiro:—Akubetsu (Sept. 8, 1925, m.); Bokke (Akan) (Sept. 9, 1925; Sept. 13, 1925, m.); Nanamagari (Akan) (Sept. 15, 1925, m.). Prov. Nemuro:—Nemuro (July 19, 1924, m.).

On leaves and stems of *Hypericum yezoense* MAXIM. (*Yezo-otogiri*).

Prov. Shiribeshi:—Akaiwa (Aug. 7, 1924, m.). Prov. Kitami:—Momoiwa (Aug. 9, 1923, K. TOGASHI).

2. *Melampsora Kusanoi* DIETEL in ENGL. Bot. Jahrb. XXXVII, p. 104, 1905—SACC. Syll. XXI, p. 601—SYD. Monogr. Ured. III, p. 386, 1914. (HIRATS. in Transact. Sapporo Nat. Hist. Soc. IX, p. 234, 1927—SYD. in Ann. Myc. XI, p. 109, 1913—TOGASHI in Jap. Jour. Bot. II, p. 82, 1924).

HAB. On leaves of *Hypericum Ascyron* L. (*Tomoeshô*).

Prov. Shiribeshi:—Zenibako (Nov. 1, 1925, m.). Prov. Iburi:—Chitose (Oct. 16, 1922, Y. HOMMA). Prov. Ishikari:—Sapporo (Aug. 18, 1895; Oct. 7, 1894, Naoharu HIRATSUKA); Mt. Moiwa (Aug. 7, 1924,

H. TAKASUGI); Maruyama (Sept. 9, 1925, m.); Garugawa (Sept. 9, 1924, m.). Prov. Kushiro:—Nanamagari (Akan) (Sept. 9, 1925, m.); Onnemoshiri (Aug. 19, 1926, m.).

On leaves of *Hypericum crassifolium* NAKAI (*H. virginicum* L. var. *japonicum* MATSUM., *Elodes japonica* BL.) (*Mizu-otogiri*).

Prov. Shiribeshi:—Zenibako (Aug. 5, 1895, Naoharu HIRATSUKA). Prov. Iburi:—Chitose (Sept. 3, 1926, m.). Prov. Ishikari:—Horomui (Aug. 25, 1923; Oct. 15, 1925, m.). Prov. Kitami:—Otomari (Rishiri) (Oct. 8, 1923, K. TOGASHI). Prov. Kushiro:—Shitakara (Sept. 16, 1925, m.).

On leaves of *Hypericum kamtschaticum* LEDEB. (*Iwa-otogiri*.)

Prov. Ishirikari:—Mt. Kuro-dake (Aug. 18, 1925; Sept. 12, 1926, m.).

REMARKS:—This endemic species was described by DIETEL in 1905 from a specimen on *Hypericum Ascyron* L. collected by S. KUSANO in Tokyo. In Hokkaidô, we have collected not only *Melampsora* parasitic on *Hypericum Ascyron* L., but also on *Hypericum crassifolium* NAKAI and *H. kamtschaticum* LEDEB.

3. *Melampsora Euphorbiae* (SCHUB.) CASTAGNE in Observ. Myc. II, p. 18, 1843—ARTH. in N. Amer. Fl. VII, p. 670, 1925—SYD. Monogr. Ured. III, p. 378, 1914.

SYN. *Xyloma (Placuntium) Euphorbiae* SCHUBERT in H. Ficinus Fl. Gegend um Dresden, II, p. 310, 1823.

HAB. On leaves of *Euphorbia adenochlora* MORR. et DECNE. (*Nourushi*).

Prov. Oshima:—Kamiiso (July 12, 1890, K. MIYABE).

REMARKS:—The specimen is one collected by Dr. K. MIYABE at Kamiiso near Hakodate in the southern Hokkaidô. It bears both uredo- and teleutospores. But, its aecidial stage is still unknown in our country. The character of this species is as follows:—

Uredosori mostly hypophyllous, rarely on the stems, scattered, round or oblong; uredospores globose or subglobose, $15.0-19.8 \times 14.4-18.0 \mu$; epispore colourless, echinulate; paraphyses numerous, capitate; teleutosori amphigenous or on the stems, subepidermal, reddish brown to black; teleutospores prismatic, $27.0-51.0 \times 7.2-15.0 \mu$, yellowish brown, not thickened at apex.

This species is new to the mycological flora of Japan.

4. *Melampsora liniperda* (KÖRN.) PALM in Svensk bot. Tidskr. IV, p. (5), 1910—HIRATS. in Jour. Soc. Agric. & Forestr. Sapporo, XVIII, p. 206, 1926—LIND, Danish Fungi, p. 292, 1913—SACC. Syll. XXIII, p. 833.

SYN. *Melampsora Lini* TUL. var. *liniperda* KÖRN. in Land- u. Forstw. Zeit. Preussen, p. 42, 1865.

HAB. On leaves, bracts and stems of *Linum usitatissimum* L. (*Ama*) (*cult.*)

Prov. Ishikari:—Sapporo (June 9, 1925; Aug. 20, 1923; Aug. 25, 1924; Sept. 1, 1924, m.); Kotoni (Aug. 1924; Aug. 8, 1925, m.; Oct. 1914, K. NAKAJIMA); Kuriyama (Nov. 3, 1923, Naoharu HIRATSUKA); Horomui (Aug. 17, 1923, m.); Jôzankei (Oct. 16, 1924, m.); Nopporo (Sept. 15, 1921, K. TOGASHI); Shimofurano (Aug. 15, 1924, I. KOBAYASHI). Prov. Teshio:—Nayoro (Aug. 2, 1924, I. KOBAYASHI). Prov. Kitami:—Nokkeushi (Aug. 23, 1924, m.).

5. *Melampsora Larici-Capraearum* KLEBAHN in Forstl. naturw. Zeitschr. p. 469, 1897—BUBÁK, Rostpilze Böhmens, p. 197, 1908—FISCH. Ured. Schw. p. 483, fig. 312, 1904—GROVE, Brit. Rust Fungi, p. 338, fig. 254, 255, 1913—LIRO, Ured. Fenn. p. 541, 1908—SYD. Monogr. Ured. III, p. 353, tab. XIV, fig. 141, 1914—TROTT. Fl. Ital. Crypt. Ured. p. 412, 1914. (HIRATS. in Jour. Soc. Agric. & Forestr. Sapporo, XIX, p. 189, 1927; in Transact. Sapporo Nat. Hist. Soc. IX, p. 234, 1927—TOGASHI & HIRATS. in Jour. Soc. Agric. & Forestr. Sapporo, XVI, p. 75, 1924).

HAB. On leaves of *Salix Caprea* L. (*Bakko-yanagi*).

Prov. Shiribeshi:—Hariusu (July 10, 1924, m.); Zenibako (Nov. 1, 1925, m.). Prov. Ishikari:—Maruyama (July 3, 1924; Oct. 3, 1924; Nov. 14, 1925, m.); Mt. Moiwa (June 22, 1924; Aug. 13, 1924; Oct. 3, 1924, m.); Mt. Teine (Oct. 12, 1924, m.). Prov. Kitami:—Noshappu-saki (Wakkanai) (Oct. 15, 1923, m.). Prov. Kushiro:—Bokke (Akan) (Sept. 13, 1925, m.); Shirikomabetsu (Sept. 11, 1925, m.).

REMARKS:—From the related species, *Melampsora Larici-epitea* KLEB., the present fungus may easily be distinguished by the thicker and darker apex of teleutospores. This species develops its aecidia on species of *Larix*. In Europe, cultures have been conducted by various authors. In our country, the writer has also proved by the cultural experiments that its aecidia occur on the leaves of *Larix Kaempferi* SARG.

6. *Melampsora Larici-epitea* KLEBAHN in Zeitschr. f. Pflanzenkr. IX, p. 88, 1899—BUBÁK, Rostpilze Böhmens, p. 197, fig. 51, 1980—FISCH. Ured. p. 485, fig. 313, 1904—GROVE, Brit. Rust Fungi, p. 340, fig. 257, 258, 1913—HIRATS. in Jour. Soc. Agric. & Forestr. Sapporo, XIX, p. 180, 1927—LIRO, Ured. Fenn. p. 551, 1908—MATSUMOTO in Transact. Sapporo Nat. Hist. Soc. VI, p. 32, fig. 4, 1915—SYD. Monogr. Ured. III, p. 355, 1914—TROT. Fl. Ital. Crypt. Ured. p. 412, fig. 106, 1914. (HIRATS. in Transact. Sapporo Nat. Hist. Soc. IX, p. 234, 1927).

SYN. *Melampsora Larici-daphnoidis* KLEB. in Pringsh. Jahrb. f. wissenschaftl. Bot. XXXIV, p. 356, 1900.

M. Larici-daphnoidis MATSUMOTO (non KLEBAHN) in Transact. Sapporo Nat. Hist. Soc. VI, p. 33, fig. 5, 1915.

M. Larici-Miyabeana MIYABE et MATSUMOTO in Transact. Sapporo Nat. Hist. Soc. VI, p. 30, fig. 2, 1915.

M. Larici-opaca MIYABE et MATSUMOTO in Transact. Sapporo Nat. Hist. Soc. VI, p. 31, fig. 3, 1915. (TOGASHI in Jap. Jour. Bot. II, p. 82, 1924—TOGASHI & HIRATS. in Jour. Soc. Agric. & Forestr. Sapporo, XVI, p. 75, 1924).

HAB. On leaves of *Salix Miyabeana* v. SEEM. (*Yezo-kawa-yanagi*).

Prov. Ishikari :—Sapporo (Aug. 29, 1924 ; Oct. 6, 1922 ; Oct. 27, 1925 ; Nov. 18, 1925, m.) ; Mt. Teine (Oct. 5, 1925, m.). Prov. Tokachi :—Obihiro (Sept. 21, 1926, Naoharu HIRATSUKA). Prov. Hidaka :—Shizunai (Aug. 4, 1927, Naoharu HIRATSUKA).

On leaves of *Salix rorida* LACKS. (*S. daphnoides* LEDEB.) (*Yezo-yanagi*).

Prov. Ishikari : Sapporo (Aug. 29, 1924 ; Oct. 6, 1922 ; Oct. 27, 1925 ; Nov. 3, 1925, m.).

On leaves of *Salix sachalinensis* FR. SCHM. (*S. opaca* ANDERS.) (*Nagaba-yanagi*).

Prov. Oshima :—Ônuma (Oct. 29, 1922, m.) ; Mt. Komagatake (Sept. 28, 1924, m.) ; Nakayama-tôge (Oct. 27, 1922, m.). Prov. Shiribeshi :—Mt. Yoichi (July 22, 1923, m.). Prov. Ishikari :—Sapporo (June 26, 1923 ; Aug. 29, 1924 ; Oct. 27, 1924, m.) ; Maruyama (Oct. 21, 1924, m.) ; Mt. Teine (Oct. 12, 1924, m.) ; Bibai (Sept. 12, 1920, K. TOGASHI) ; Horomui (Oct. 15, 1925, m.). Prov. Iburi :—Chitose (Sept. 19, 1926, m.). Prov. Hidaka :—Shizunai (Aug. 4, 1927, Naoharu HIRATSUKA). Prov. Kitami :—Wakkanai (Oct. 15, 1923, m.) ; Oniwaki (Rishiri) (Aug.

4, 1922, K. TOGASHI). Prov. Tokachi :—Obihiro (Sept. 21, 1926, Naoharu HIRATSUKA). Prov. Kushiro :—Akubetsu (Akan) (Sept. 7, 1925, m.); Shirikomabetsu (Sept. 11, 1925, m.).

On leaves of *Salix viminalis* L. var. *yezoensis* C. K. SCHN. (*Kinu-yanagi*).

Prov. Oshima :—Ônuma (Oct. 29, 1922, m.). Prov. Ishikari : Sapporo (April 8, 1896; Sept. 22, 1896; Oct. 20, 1895, Naoharu HIRATSUKA); Maruyama (July 3, 1924; Aug. 17, 1924; Aug. 19, 1924; Sept. 14, 1924; Sept. 16, 1922, m.); Mt. Teine (Oct. 5, 1924, m.); Horomui (Oct. 15, 1925, m.); Sounbetsu (Sept. 13, 1926, m.). Prov. Hidaka :—Shizunai (Aug. 4, 1927, Naoharu HIRATSUKA). Prov. Tokachi :—Obihiro (Sept. 21, 1926, Naoharu HIRATSUKA). Prov. Kushiro :—Rubeshibe (Akan) (Sept. 9, 1925, m.); Shirikomabetsu (Akan) (Sept. 11, 1925, m.).

REMARKS :— Each fungus on *Salix Miyabeana*, *S. vorida*, *S. sachalinensis* and *S. viminalis* var. *yezoensis* was described by T. MATSUMOTO⁽¹⁾ as a distinct species, *Melampsora Larici-Miyabeana*, *M. Larici-daphnoidis*, *M. Larici-opaca* and *M. Larici-epitea* respectively. The writer also proved that these fungi produce their aecidia on species of *Larix*, as the results of MATSUMOTO. However, there is not any difference among them in their morphological characters. In the present paper, the writer included these fungi into a collective species, *Melampsora Larici-epitea* KLEB.

7. *Melampsora Larici-Urbaniiana* MATSUMOTO in Ann. Missouri Gard. VI, p. 311, fig. 1, 2, 3, 1919. (HIRATS. in Jour. Soc. Agric. & Forestr. Sapporo, XIX, p. 193, 1927).

HAB. On leaves of *Salix Urbaniiana* v. SEEM. (*Ôba-yanagi*).

Prov. Ishikari :—Sapporo (July 15, 1895, Naoharu HIRATSUKA; Aug. 21, 1905, K. MIYABE; Aug. 29, 1924; Aug. 30, 1924; Nov. 3, 1925; Nov. 18, 1925, m.); Hassabu (Kotoni) (July 27, 1923, m.). Prov. Kitami :—Wakkanai (Oct. 15, 1923, m.).

8. *Melampsora yezoensis* MIYABE et MATSUMOTO in Transact. Sapporo Nat. Hist. Soc. VI, p. 29, fig. 1, 1915.

HAB. On leaves of *Corydalis ambigua* CHAM. et SCHL. (*Yezo-nogensaku*).

(1) l.c.

Prov. Ishikari :—Sapporo (May 10, 1920, K. TOGASHI ; May 15, 1920, S. ITÔ ; May 16, 1923, m.).

On leaves of *Salix jessoensis* v. SEEM. (*Shiro-yanagi*).

Prov. Ishikari :—Sapporo (Aug. 29, 1924 ; Oct. 27, 1925, m.) ; Mt. Moiwa (Oct. 3, 1924, m.).

9. *Melampsora Larici-populina* KLEBAHN in Zeitschr. f. Pflanzenkr. XII, p. 43, 1902—BUBÁK, Rostpilze Böhmens, p. 205, fig. 57, 1908—FISCH. Ured. Schw. p. 502, fig. 316, 1904—GROVE, Brit. Rust Fungi, p. 348, fig. 261, 1913—LIRO, Ured. Fenn. p. 528, 1908—MATSUMOTO in Ann. Missouri Bot. Gard. VI, p. 314, 1919—SYD. Monogr. Ured. III, p. 346, 1914—TROTT. Fl. Ital. Crypt. Ured. p. 401, fig. 101, 1914. (HIRATS. in Jour. Soc. Agric. & Forestr. Sapporo, XIX, p. 188, 1927—TOGASHI in Jap. Jour. Bot. II, p. 82, 1924).

HAB. On leaves of *Populus Maximowiczii* A. HENRY (*P. balsamifera* L. var. *suaveolens* BUR.) (*Doronoki*).

Prov. Iburi :—Numanohata (Sept. 3, 1926, m.). Prov. Ishikari :—Sapporo (April 3, 1896, Naoharu HIRATSUKA ; Aug. 28, 1924 ; Aug. 29, 1924 ; Sept. 10, 1922 ; Sept. 10, 1924, m.) ; Maruyama (Sept. 11, 1920, K. TOGASHI ; Sept. 23, 1923 ; Sept. 25, 1924, m.) ; Mt. Moiwa (Sept. 14, 1924 ; Oct. 3, 1924 ; Oct. 5, 1924, m.) ; Mt. Teine (Sept. 2, 1924, m.).

On leaves of *Populus nigra* L. var. *italica* DU ROI (*Seiyô-hakoyanagi*).

Prov. Oshima :—Hakodate (Sept. 29, 1924, m.) ; Ônuma (Oct. 29, 1922, m.). Prov. Ishikari :—Sapporo (Aug. 15, 1924 ; Sept. 9, 1924 ; Sept. 12, 1922, m.) ; Maruyama (Sept. 23, 1923, m.) ; Mt. Moiwa (Sept. 10, 1922, m.) ; Mt. Teine (Sept. 21, 1924 ; Oct. 5, 1924, m.). Prov. Kitami :—Sempôji (Rishiri) (Oct. 8, 1923, K. TOGASHI). Prov. Tokachi :—Obihiro (Sept. 21, 1926, Naoharu HIRATSUKA).

REMARKS :—The present species can easily be distinguished from the related species, *Melampsora Medusae* THÜM. by the position of teleutosori and also by the size of the uredo- and teleutospores. In Japan, the genetic connection of the present species has been confirmed by MATSUMOTO (1919) and the writer (1925 and 1926).

10. *Melampsora Magnusiana* G. WAGNER in Österr. bot. Zeitschr. XLVI, p. 273, 1896—BUBÁK, Rostpilze Böhmens, p. 204, fig. 55, 1908—FISCH. Ured. Schw. p. 500, 1904—LIRO, Ured. Fenn. p. 533,

1908—SYD. Monogr. Ured. III, p. 341, 1914—TROT. Fl. Ital. Crypt. Ured. p. 405, 1914. (HIRATS. in Transact. Sapporo Nat. Hist. Soc. IX, p. 234, 1927).

HAB. On leaves of *Populus Sieboldii* MIQ. (*P. tremula* L. var. *villosa* FR. et SAV.; *P. tremula* FR. SCHM., etc.) (*Yamanarashi*).

Prov. Oshima:—Mt. Komagatake (Sept. 28, 1924, m.). Prov. Iburi:—Numanohata (Sept. 3, 1926, m.). Prov. Ishikari:—Sapporo (Oct. 17, 1895, Naoharu HIRATSUKA); Nopporo (Sept. 28, 1923, m.); Mt. Moiwa (Oct. 25, 1924; Nov. 3, 1925, m.). Prov. Teshio:—Nayoro (Sept. 23, 1926, Naoharu HIRATSUKA). Prov. Kushiro:—Shirikomabetsu (Akan) (Sept. 11, 1925, m.).

REMARKS: In 1896, WAGNER⁽¹⁾ proved that the present species on *Populus tremula* has a genetic connection with *Caeoma Chelidoni* P. MAGN. on *Chelidonium majus* L. In our country, the relation has been confirmed by the writer in the spring of 1926.

Chnoopsora DIETEL

11. *Chnoopsora Itôana*⁽²⁾ HIRATSUKA nov. sp.

Soris teleutosporiferis hypophyllis, subepidermalibus, primitus minutis, tandem omnoni confluentibus majoribusque, usque 2-8 mm. latis, crustaceis, soridide flavis, denique albicantibus; teleutosporis cylindraceis vel clavatis, flavidis, levibus, $27.0-37.6 \times 9.0-14.4 \mu$, episporio 1μ crasso.

HAB. On leaves of *Oxalis Acetosella* L. (*Ko-miyama-katabami*).

Prov. Ishikari:—Mt. Teine (June 17, 1925, m.); Jôzankei (June, 1906, S. ITÔ); Mt. Kuro-dake (Aug. 4, 1925; Aug. 17, 1925, K. MIYABE & Naohide HIRATSUKA); Sôunbetsu (July 26, 1926, m.); Kushinai (July 18, 1926, m.). Prov. Iburi:—Chitose (Oct. 16, 1922, Y. HOMMA). Prov. Tokachi:—Panke-nikoro (Kuttari) (July 9, 1925, m.). Prov. Kushiro:—Mt. Meakan (Aug. 7, 1923, m.). Prov. Nemuro:—Ochiishi (July 16, 1924, m.).

REMARKS:—The genus *Chnoopsora* was established by DIETEL⁽³⁾ with its type species, *Chnoopsora Sancti-Johannis* (BARCL.) DIET. on

(1) Österr. Bot. Zeitschr. XLVI, p. 273, 1896.

(2) Named in honour of Prof. Dr. S. ITÔ.

(3) Ann. Myc. IV, p. 423, 1906.

Hypericum cernuum, in 1906. Besides it, the following two species of this genus have been recorded by DIETEL and SYDOW: they are *Chnoopsora Butleri* DIET. et SYD. and *C. rigida* (HAR. et PAT.) SYD. The writer examined these three species in SYDOW's exsiccati for comparison. Our fungus is distinguishable from *Chnoopsora Sancti-Johannis* by the absence of its aecidial stage and the shape of the teleutospores, from *C. Butleri* by the smaller spores and from *C. rigida* by the colour of its sori, somewhat smaller spores, etc. In Hokkaidô, the present fungus is commonly met with wherever the host plant is found.

SUBFAM. II. PHAKOPSOREAE

Phakopsora DIETEL

12. *Phakopsora Artemisiae* HIRATSUKA nov. sp.

Soris uredosporiferis amphigenis, plerumque epiphyllis, sparsis vel irregulariter aggregatis, minutissimis, diu epidermide tectis, tandem poro centrali vel saepius irregulariter apertis, sine pseudoperidio; paraphysibus clavatis vel capitatis, irregularibus, rectis vel introrsum curvulis, hyalinis vel subhyalinis, $38.0-41.4\ \mu$ longis; uredosporis ovatis vel ellipsoideis, breviter echinulatis, pallide flavidis, $23.4-36.0 \times 16.2-25.2\ \mu$, episporio hyalino, $1.5\ \mu$ crasso; poris germinationis inconspicuus; soris teleutosporiferis plerumque hypophyllis, minutis, $0.1-0.5\ \text{mm}$ diam., flavobrunneis, in maturitate obscure brunneis, epidermide tectis; teleutosporis in strata, 3-5 superpositis, lentiforme formantes, oblongis vel cubicis, flavidis usque obscure brunneis, $19.4-32.4 \times 14.4-18.0\ \mu$, episporio $1-2\ \mu$ crasso, superioribus ad apicem incrassatis ($2.0-3.6\ \mu$).

HAB. On leaves of *Artemisia vulgaris* L. var. *yezoana* KUDÔ (*Yezoyomogi*.)

Prov. Ishikari: Sankakuyama (Sapporo) (Sept. 2, 1922, m.); Maruyama (Oct. 11, 1924, I. TANAKA); Mt. Moiwa (Oct. 19, 1924, m.).

REMARKS:— This fungus differs from *Phakopsora Compositiarum* I. MIYAKE by the position of uredosori, the size of uredospores, etc.

SUBFAM. III. PUCCINIASTREAE

Melampsorella SCHRÖT.

13. *Melampsorella Caryophyllacearum* SCHRÖTER in Hedw. XIII, p. 85, 1874—BUBÁK, Rostpilze Böhmens, p. 211, fig. 59, 1908—FISCH. Ured. Schw. p. 516, fig. 322-326, 1904—GROVE, Brit. Rust Fungi, p. 360, fig. 269, 270, 1913—SYD. Monogr. Ured. III, p. 433, 1915—TROTT. Fl. Ital. Crypt. Ured. p. 425, 1914. (SYD. in Ann. Myc. XI, p. 110, 1913—TOGASHI in Jap. Jour. Bot. II, p. 82, 1924).

HAB. On leaves of *Abies Mayriana* MIYABE et KUDÔ (*Ao-todomatsu*).

Prov. Ishikari: Maruyama (May, 1927, m.); Nopporo (May, 1927, T. ISHIYAMA, S. IWADARE & Naohide HIRATSUKA).

On leaves of *Cerastium triviale* LINK. var. *glandulosum* KOCH. (*Miminagusa*).

Prov. Oshima:—Mt. Komagatake (Sept. 28, 1924, m.). Prov. Ishikari:—Sapporo (May 20, 1896, Naoharu HIRATSUKA); Maruyama (June 13, 1925; June 29, 1924; Nov. 4, 1924, m.; Sept. 24, 1907, M. MIURA); Sankakuyama (Aug. 20, 1923, m.); Mt. Kuro-dake (Aug. 5, 1925). Prov. Kitami:—Sempôji (Rishiri) (Oct. 8, 1923, K. TOGASHI). Prov. Tokachi:—Shikaribetsu-numa (July 7, 1925, m.).

On leaves of *Stellaria media* CYR. (*Hakobe*).

Prov. Ishikari:—Sapporo (May 20, 1896, Naoharu HIRATSUKA); Maruyama (June 29, 1924, m.).

On leaves of *Stellaria yezoensis* MAXIM. (*Yezo-fusuma*).

Prov. Kitami:—Mt. Rishiri (Rishiri) (Aug. 5, 1922, K. TOGASHI). Prov. Nemuro:—Ochiishi (July 16, 1924, m.).

Melampsoridium KLEB.

14. *Melampsoridium Alni* (THÜM.) DIETEL in Engl.-Prantl, Natürl. Pflanzenfam. I, 1. Abt.**, p. 551, 1900—ARTH. in N. Amer. Fl. VII, p. 680, 1925, p.p.—SYD. Monogr. Ured. III, p. 430, 1915, p.p.—HIRATS. in Jour. Facul. Agric. Hokkaido Imp. Univ. XXI, p. 7, 1927. (HIRATS. in Transact. Sapporo Nat. Hist. Soc. IX, p. 234, 1927—TOGASHI in Jap. Jour. Bot. II, p. 82, 1924).

SYN. *Melampsora Alni* THÜM. in Bull. Soc. Impér. Nat. Moscou, LIII, p. 226, 1878—SACC. Syll. VII, p. 595.

HAB. On leaves of *Alnus Maximowiczii* CALL. (= *A. viridis* DC. var. *sibirica* REGEL) (*Miyama-hannoki*).

Prov. Oshima:—Ônuma (Oct. 29, 1922, m.); Mt. Komagatake (Sept. 28, 1924, m.). Prov. Shiribeshi:—Raiden-tôge (Oct. 5, 1901, G. YAMADA). Prov. Ishikari:—Sapporo (Oct. 8, 1924; Oct. 9, 1924; Oct. 15, 1924, m.); Yamahana (Oct. 25, 1924, m.); Mt. Moiwa (Oct. 6, 1924, H. TAKASUGI); Makomana (Oct. 23, 1924, m.); Mt. Teine (Sept. 27, 1925; Oct. 19, 1924, m.); Mt. Sapporo (Sept. 23, 1922, m.). Prov. Kitami:—Oshidomari (Rishiri) (Oct. 10, 1923, K. TOGASHI); Kabuka (Rebun) (Oct. 12, 1923, K. TOGASHI). Prov. Kushiro:—Mt. Oakan (Sept. 10, 1925, m.).

15. *Melampsoridium Alni-pendulae* HIRATSUKA in Jour. Facul. Agric. Hokkaido Imp. Univ. XXI, p. 8, 1927.

HAB. On leaves of *Alnus pendula* MATSUM. (= *A. firma* SIEB. et ZUCC. var. *multinervis* REGEL) (*Hime-yashabushi*).

Prov. Shiribeshi:—Zenibako (Sept. 9, 1926, S. IWADARE; Oct. 10, 1926, m.).

16. *Melampsoridium Hiratsukanum* ITÔ in Jour. Facul. Agric. Hokkaido Imp. Univ. XXI, p. 9, 1927. (HIRATS. in Transact. Sapporo Nat. Hist. Soc. IX, p. 235, 1927).

SYN. *Melampsora Alni* HIRATS. (non THÜMEN) in Bot. Mag. Tokyo, XI, p. 46, tab. IV. fig. 4-11, 1897.

Melampsoridium Alni SYD. (non DIETEL) Monogr. Ured. III, p. 430, 1915, p.p. (SYD. in Ann. Myc. XI, p. 110, 1913).

HAB. On leaves of *Alnus hirsuta* TURCZ. (*Ke-yamahannoki*).

Prov. Oshima:—Mt. Komagatake (Sept. 28, 1924, m.). Prov. Iburi:—Mt. Yoichi (July 22, 1923, m.); Numanohata (Nov. 1, 1900, K. MIYABE & G. YAMADA); Chitose (Sept. 19, 1926, m.; Oct. 10, 1900, G. YAMADA). Prov. Shiribeshi:—Zenibako (Oct. 6, 1895, K. MIYABE); Raiden-tôge (Oct. 5, 1901, G. YAMADA). Prov. Ishikari:—Sapporo (Sept. 1898, J. HANZAWA; Sept. 21, 1900, Naoharu HIRATSUKA; Oct. 9, 1924, m.); Maruyama (Aug. 3, 1924; Aug. 17, 1924; Sept. 14, 1924; Sept. 16, 1922; Oct. 11, 1924, m.); Hattarubetsu (July, 1916, S. ITÔ); Mt. Moiwa (Aug. 29, 1924; Aug. 31, 1922, m.); Makomanai (Oct. 23,

1924, m.); Garugawa (Oct. 12, 1924, m.; Oct. 24, 1905, J. HANZAWA); Mt. Teine (Sept. 2, 1924, m.); Jôzankei (Oct. 16, 1924, m.); Mt. Sapporo (Sept. 28, 1922, m.). Prov. Teshio:—Nayoro (Sept. 23, 1926, Naoharu HIRATSUKA). Prov. Hidaka:—Mt. Apoi (Aug. 17, 1912, K. KONDÔ). Prov. Kushiro:—Pirikanepu (Akan) (Sept. 9, 1925, m.); Mt. Meakan (Sept. 14, 1925, m.); Rubeshibe (Akan) (Sept. 8, 1925, m.); Akubetsu (Akan) (Sept. 7, 1925, m.); Shirikomabetsu (Akan) (Sept. 11, 1925, m.); Onne-moshiri (Akan) (Aug. 19, 1926, m.).

17. *Melampsoridium betulinum* (DESM.) KLEBAHN in Zeitschr. f. Pflanzenkr. IX, p. 22, 1899—BUBÁK, Rostpilze Böhmens, p. 210, fig. 58, 1908—FISCH. Ured. Schw. p. 512, fig. 320, 1904—GROVE, Brit. Rust Fungi, p. 358, fig. 267, 268, 1913—SACC. Syll. XVII, p. 464—SYD. Monogr. Ured. III, p. 425, 1915—TROT. Fl. Ital. Crypt. Ured. p. 421, fig. 108, 1914. (HIRATS. in Transact. Sapporo Nat. Hist. Soc. IX, p. 235, 1927—SYD. in Ann. Myc. XI, p. 110, 1913).

SYN. *Melampsora betulinum* DESM. Pl. Crypt. de France, No. 2047, 1850.

HAB. On leaves of *Betula japonica* SIEB. (*Shira-kamba*).

Prov. Oshima:—Mt. Komagatake (Sept. 28, 1924, m.). Prov. Shiribeshi:—Raiden-tôge (Oct. 5, 1901, G. YAMADA); Zenibako (Oct. 10, 1926, m.). Prov. Ishikari:—Sapporo (Aug. 3, 1899; Sept. 27, 1900; Oct. 8, 1894; Oct. 22, 1894, Naoharu HIRATSUKA; Sept. 27, 1924, m.; Oct. 30, 1894, Y. TAKAHASHI); Maruyama (Aug. 29, 1924; Sept. 25, 1924; Oct. 21, 1924, m.; Oct. 30, 1922, K. TOGASHI); Mt. Moiwa (Sept. 30, 1923; Oct. 31, 1922, m.); Hirakishi-mura (Oct. 8, 1894, Naoharu HIRATSUKA); Mt. Teine (Oct. 5, 1924, m.); Misomai (Oct. 11, 1905, J. HANZAWA). Prov. Kushiro:—Shirikomabetsu (Akan) (Sept. 11, 1925, m.).

18. *Melampsoridium Carpini* (FUCK.) DIETEL in ENGL.—PRANTL, Natürl. Pflanzenfam. I, 1. Abt.**, p. 551, 1900—ARTH. in N. Amer. Fl. VII. p. 680, 1925—FISCH. Ured. Schw. p. 515, fig. 321, 1904—SYD. Monogr. Ured. III, p. 428, 1915.

SYN. *Melampsora Carpini* FUCK. Symb. Myc. p. 44, 1859.

HAB. On leaves of *Carpinus cordata* BL. (*Sawa-shiba*).

Prov. Oshima:—Ônuma (Oct. 29, 1922, m.).

***Pucciniastrum* OTTH**

19. *Pucciniastrum Miyabeaenum* HIRATSUKA in Bot. Mag. Tokyo, XII, p. 33, 1898—SACC. Syll. XVI, p. 320—SYD. Monogr. Ured. III, p. 451, 1915.

HAB. On leaves of *Viburnum furcatum* BL. (Mushikari).

Prov. Oshima:—Mt. Komagatake (Sept. 28, 1924, m.). Prov. Shiribeshi:—Raiden-tôge (Oct. 4, 1901, G. YAMADA). Prov. Iburi:—Chitose (Oct. 12, 1900, G. YAMADA). Prov. Ishikari:—Sapporo (Sept. 22, 1896, Naoharu HIRATSUKA; Sept. 30, 1896, G. YAMADA; Oct. 4, 1896, K. MIYABE); Mt. Moiwa (Sept. 21, 1896, Naoharu HIRATSUKA; Aug. 29, 1924; Oct. 3, 1924; Oct. 13, 1923, m.); Mt. Teine (Oct. 5, 1924; Oct. 17, 1925, m.); Garugawa (Aug. 14, 1904, K. MIYABE); Jôzankei (Aug. 24, 1898, K. MIYABE); Nopporo (Sept. 15, 1921, K. TOGASHI; Sept. 26, 1926, Y. HOMMA).

20. *Pucciniastrum Styracinum* HIRATSUKA in Bot. Mag. Tokyo, XII, p. 32, tab. II, fig. 7—13, 1898—SACC. Syll. XVI, p. 319—SYD. Monogr. Ured. III, p. 451, 1915.

HAB. On leaves of *Styrax Obassia* SIEB. et ZUCC. (*Hakuunboku*).

Prov. Ishikari:—Sapporo (Sept. 1898, J. HANZAWA; Oct. 3, 1895, Naoharu HIRATSUKA; Oct. 4, 1896, K. MIYABE; Sept. 22, 1896, Y. TOKUBUCHI; Nov. 3, 1924, m.); Mt. Moiwa (Nov. 3, 1897, K. MIYABE); Nopporo (Oct. 27, 1924, S. KAMEI); Mt. Teine (Nov. 2, 1924, m.).

21. *Pucciniastrum Pyrolae* (KARST.) SCHRÖTER in Jahresber. Schles. Ges. f. vaterl. Kultur, LVIII, p. 167, 1880—HIRATS. in Jour. Facul. Agric. Hokkaido Imp. Univ. XXI, p. 28, 1927—SYD. Monogr. Ured. III, p. 455, 1915. (HIRATS. in Transact. Sapporo Nat. Hist. Soc. IX, p. 235, 1927).

SYN. *Thekopsora Pyrolae* KARST. Myc. Fenn. IV, p. 59, 1879.

HAB. On leaves of *Chimaphila umbellata* NUTT. (*Ô-umegasasô*). Prov. Iburi:—Numanohata (Oct. 17, 1926, m.).

On leaves of *Pirola minor* L. (*Yezo-ichiyakusô*).

Prov. Kitami:—Mt. Rishiri (Aug. 1899, T. KAWAKAMI).

On leaves of *Pirola renifolia* MAXIM. (*Jinyô-ichiyaku*).

Prov. Oshima :—Ônuma (May 30, 1925, m.). Prov. Ishikari :—Jôzankei (Aug. 5, 1923, Naoharu HIRATSUKA); Mt. Sapporo (June 25, 1914, B. ISHIDA).

On leaves of *Pirola secunda* L. var. *vulgaris* HERD. (*Yama-ichiya-kusô*).

Prov. Ishikari :—Nopporo (June 16, 1923, Y. HOMMA); Mt. Teine (June 27, 1925, m.); Jôzankei (Aug. 24, 1898, K. MIYABE). Prov. Tokachi :—Mt. Memuro (July 22, 1914, S. NISHIDA). Prov. Kushiro :—Mt. Meakan (July 19, 1921, K. TOGASHI; Sept. 14, 1925, m.).

22. *Pucciniastrum Circaeae* (THÜM.) SPEGAZZINI in Dec. Myc. Ital. No. 65, 1879—BUBÁK, Rostpilze Böhmens, p. 186, 1908—FISCH. Ured. Schw. p. 461, fig. 302, 1904—GROVE, Brit. Rust Fungi, p. 365, fig. 273, 1913—HIRATS. in Jour. Facul. Agric. Hokkaido Imp. Univ. XXI, p. 25, 1927—LIRO, Ured. Fenn. p. 511, 1908—SACC. Syll. VII, p. 763—SYD. Monogr. Ured. III, p. 445, tab. XIX, fig. 160, 1915—TROT. Fl. Ital. Crypt. Ured. p. 382, fig. 31, 1914. (HIRATS in Transact. Sapporo Nat. Hist. Soc. IX, p. 235, 1927).

SYN. *Melampsora Circaeae* THÜM. Myc. Univ. No. 447, 1876.

HAB. On leaves of *Circaea alpina* L. (*Miyama-tanitate*).

Prov. Ishikari :—Mt. Kuro-dake (Aug. 4, 1925; Sept. 12, 1926, m.). Prov. Kushiro :—Mt. Meakan (July 21, 1922, m.).

On leaves of *Circaea cardiophylla* MAK. (*Ushitakisô*).

Prov. Ishikari :—Yuni (Sept. 9, 1899, G. YAMADA); Yûbari (Sept. 1899, T. KAWAKAMI).

On leaves of *Circaea erubescens* FR. et SAV. (*Tanitate*).

Prov. Iburi :—Rebunge (July 25, 1897, G. YAMADA).

23. *Pucciniastrum Epilobii* OTTH in Mitteil. Naturforsch. Ges. Bern (1861), p. 72, 1861—BUBÁK, Rostpilze Böhmens, p. 185, 1908—FISCH. Ured. Schw. p. 459, 1904—LIRO, Ured. Fenn. p. 509, 1908—SACC. Syll. VII, p. 762—SYD. Monogr. Ured. III, p. 444, 1915—TROT. Fl. Ital. Crypt. Ured. p. 381, 1914. (HIRATS. in Transact. Sapporo Nat. Hist. Soc. IX, p. 235, 1927—SYD. in Ann. Myc. XI, p. 110, 1913—TOGASHI in Jap. Jour. Bot. II, p. 83, 1924).

SYN. *Pucciniastrum Abieti-Chamaenerii* KLEB. in Pringsh. Jahrb. f. wissenschaftl. Bot. XXXIV, p. 387, 1900.

HAB. On leaves of *Epilobium angustifolium* L. (*Yanagiran*).

Prov. Oshima:—Mt. Komagatake (Sept. 28, 1924, m.). Prov. Shiribeshi:—Otaru (Oct. 2, 1923, m.); Kutchan (July 31, 1897, G. YAMADA); Raiden-tôge (July 29, 1897, G. YAMADA). Prov. Iburi:—Noboribetsu (Sept. 2, 1914, K. MIYABE). Prov. Ishikari:—Sapporo (Sept. 20, 1925, m.); Maruyama (Aug. 19, 1924; Sept. 14, 1924, m.); Mt. Moiwa (Sept. 21, 1896, G. YAMADA; Sept. 17, 1901, J. HANZAWA); Mt. Teine (Oct. 5, 1924; Oct. 19, 1924, m.); Shinotsu (Oct. 4, 1924, m.); Mt. Sapporo (Sept. 5, 1921, K. TOGASHI); Jôzankei (Oct. 16, 1924, m.); Hiroshimamura (Sept. 3, 1915, Y. NIJIMA). Prov. Kitami:—Oshidomari (Oct. 10, 1923, K. TOGASHI). Prov. Kushiro:—Shirikomabetsu (Akan) (Sept. 11, 1925, m.); Nanamagari (Akan) (Sept. 9, 1925, m.); Mt. Oakan (Sept. 10, 1925, m.).

24. *Pucciniastrum Tiliae* MIYABE in Bot. Mag. Tokyo, XI, p. 47, tab. IV, fig. 12—20, 1897—SACC. Syll. XVI, p. 363—SYD. Monogr. Ured. III, p. 453, 1915. (HIRATS. in Transact. Sapporo Nat. Hist. Soc. IX, p. 235, 1927—SYD. in Ann. Myc. XI, p. 110, 1913).

HAB. On leaves of *Tilia japonica* SIMK. (*T. cordata* MILL. var. *japonica* MIQ.) (*Shinanoki*).

Prov. Oshima:—Mt. Komagatake (Sept. 28, 1924, m.). Prov. Shiribeshi:—Raiden-tôge (Oct. 5, 1901, G. YAMADA). Prov. Ishikari:—Sapporo (Aug. 15, 1899; Sept. 11, 1894; Sept. 22, 1896, Naoharu HIRATSUKA; Oct. 6, 1894, K. MIYABE); Bannosawa (Kotoni) (Sept. 25, 1924, m.); Mt. Moiwa (Aug. 29, 1924; Sept. 10, 1922; Sept. 23, 1922; Sept. 24, 1925; Oct. 13, 1923, m.) Shiroishi-mura (Sept. 22, 1895, Naoharu HIRATSUKA); Maruyama (Sept. 14, 1924; Sept. 25, 1924; Oct. 21, 1924, m.; Oct. 2, 1895, Naoharu HIRATSUKA; Oct. 7, 1894, K. MIYABE); Mt. Sapporo (Sept. 5, 1921, K. TOGASHI); Mt. Teine (Oct. 12, 1924, m.); Noppo (Sept. 26, 1926, Y. HOMMA). Prov. Hidaka:—Samani-sandô (Aug. 22, 1892, Y. TOKUBUCHI). Prov. Kushiro:—Bokke (Akan) (Sept. 9, 1925, m.); Mt. Oakan (Sept. 10, 1925, m.); Kutcharo (Sept. 26, 1913, K. MIYABE).

On leaves of *Tilia Maximowicziana* SHIRASAWA (*T. Miqueliana* SARG.) (*Ôba-bodaiju*).

Prov. Ishikari:—Sapporo (Sept. 17, 1890, Y. TAKAHASHI; Oct. 4, 1895; Oct. 8, 1893, Naoharu HIRATSUKA; Oct. 6, 1894, K. MIYABE); Maruyam (Aug. 29, 1924; Sept. 14, 1924; Sept. 25, 1924, m.; Oct. 4, 1895, Naoharu HIRATSUKA; Oct. 7, 1894, K. MIYABE; Oct. 30, 1920, Y. HOMMA); Mt. Moiwa (Oct. 24, 1894, K. MIYABE); Mt. Teine (Oct. 12, 1924, Nov. 24, 1925, m.); Nopporo (Sept. 26, 1926, Y. HOMMA).

25. *Pucciniastrum Agrimoniae* (DIET.) TRANZSCHEL in Script. Bot. Hort. Univ. Petropol. IV, p. 301, 1895—ARTH. in N. Amer. Fl. VII, p. 106, 1907—FISCH. Ured. Schw. p. 465, 1904—GROVE, Brit. Rust Fungi, p. 364, fig. 272, 1913—SACC. Syll. XXI, p. 733—SYD. Monogr. Ured. III, p. 446, 1915—TROTT. Fl. Ital. Crypt. Ured. p. 382, 1914. (HIRATS. in Transact. Sapporo Nat. Hist. Soc. IX, p. 235, 1927—TOGASHI in Jap. Jour. Bot. II, p. 83, 1924—TOGASHI & HIRATS. in Jour. Soc. Agric. & Forest. Sapporo, XVI, p. 76, 1924).

SYN. *Thekopsora Agrimoniae* DIET. in Hedw. XXIX, p. 153, 1890. *Pucciniastrum Agrimoniae* HIRATS. in Bot. Mag. Tokyo, XII, p. 30, pl. II, fig. 1—6, 1898.

HAB. On leaves of *Agrimonia pilosa* LEDEB. (*A. Eupatoria* L. var. *pilosa* MAK.) (*Kin-mizuhiki*).

Prov. Oshima:—Hakodate (Aug. 9, 1895, Y. TAKAHASHI); Yesashi (Aug. 4, 1890, K. M). Prov. Shiribeshi:—Raiden-tôge (Oct. 5, 1901, G. YAMADA); Zenibako (Oct. 9, 1924, m.); Ranshima (Oct. 23, 1921, Naoharu HIRATSUKA). Prov. Iburi:—Mombetsu (Aug. 14, 1890, K. MIYABE); Chitose (Sept. 2, 1896, K. MIYABE; Sept. 10, 1926, m.); Hayakita (Oct. 14, 1900, G. YAMADA). Prov. Ishikari:—Sapporo (Aug. 10, 1896, Naoharu HIRATSUKA); Maruyama (Aug. 29, 1924; Sept. 14, 1924; Sept. 23, 1923; Oct. 3, 1924; Oct. 11, 1924, m.; Oct. 23, 1920, Y. HOMMA); Makomanai (Oct. 23, 1924, m.); Bannosawa (Aug. 19, 1924, m.); Mt. Moiwa (Aug. 29, 1924; Aug. 31, 1922, m.; Sept. 11, 1902, J. HANZAWA); Takinosawa (Maruyama) (Sept. 14, 1924, m.); Mt. Teine (Sept. 2, 1924; Oct. 5, 1924; Oct. 19, 1924, m.); Kotoni (Sept. 22, 1896, Naoharu HIRATSUKA). Prov. Kitami:—Mt. Rishiri (Aug. 5, 1922, K. TOGASHI; Aug. 25, 1894, K. MIYABE); Sempôji (Rishiri) (Sept. 1, 1899, T. KAWAKAMI); Oshidomari (Rishiri) (Aug. 3, 1899, T. KAWAKAMI); Noshappu-saki (Wakkanai) (Oct. 15, 1923, m.). Prov. Hidaka:—Urakawa (Sept. 26, 1900, T. KAWAKAMI); Saruru (Aug. 12, 1892, Y. TOKUBUCHI). Prov. Kushiro:—Kutcharo (Aug.

16, 1915, K. MIYABE); Bokke (Akan) (Sept. 13, 1925, m.); Yûbetsu (Akan) (Sept. 7, 1925, m.); Nanamagari (Akan) (Sept. 9, 1925, m.).

26. *Pucciniastrum Potentillae* KOMAROV in JACZEWSKI, KOMAROV et TRANZSCHEL, Fg. Ross. exs. no. 327, 1899—ARTH. in N. Amer. Fl. VII, p. 676, 1925—SACC. Syll. XVI, p. 319—SYD. Monogr. Ured. III, p. 449, 1915.

HAB. On leaves of *Potentilla centigrana* MAXIM. (*Hime-hebiichigo*).

Prov. Oshima:—Nakayama-tôge (Oct. 27, 1922, m.). Prov. Ishikari:—Maruyama (Oct. 20, 1923, m.); Nopporo (July 12, 1924, m.); Mt. Moiwa (Oct. 31, 1922, m.).

On leaves of *Potentilla cryptotaeniae* MAXIM. (*Mitsumotosô*).

Prov. Oshima:—Hakodate (July 10, 1890, K. MIYABE). Prov. Iburi:—Chitose (Sept. 2, 1896, K. MIYABE). Prov. Ishikari:—Sapporo (Aug. 15, 1924; Sept. 1, 1924; Sept. 14, 1924; Oct. 18, 1924; Nov. 10, 1924, m.); Jôzankei (Oct. 16, 1924, m.).

On leaves of *Potentilla fragarioides* L. (*Kijimushiro*).

Prov. Iburi:—Hayakita (Oct. 14, 1900, G. YAMADA). Prov. Ishikari:—Sapporo (Sept. 28, 1894, K. MIYABE); Makomanai (Aug. 5, 1896, Y. TAKAHASHI); Kamikawa-mura (Sept. 30, 1899, T. KAWAKAMI); Sunagawa (Aug. 7, 1891, K. MIYABE); Kuriyama (Sept. 6, 1896, Naoharu HIRATSUKA). Prov. Tokachi:—Shikaribetsu-numa (July 6, 1925, m.); Kuttari (July 7, 1925, m.); Pankenikoro (Kuttari) (July 9, 1925, m.).

On leaves of *Potentilla Freyniana* BORUM. (*Mitsuba-tsuchiguri*).

Prov. Oshima:—Ônuma (Oct. 29, 1922, m.). Prov. Ishikari:—Nopporo (June 10, 1924, m.; Sept. 15, 1921, K. TOGASHI; Sept. 26, 1926, Y. HOMMA).

REMARKS:—*Potentilla centigrana* MAXIM., *P. cryptotaeniae* MAXIM. and *P. Freyniana* BORUM. are new host-plants to the present fungus.

27. *Pucciniastrum Hydrangeae-petiolaridis* HIRATSUKA in Jour. Facul. Agric. Hokkaido Imp. Univ. XXI, p. 27, 1927.

HAB. On leaves of *Hydrangea petiolaris* SIEB. et ZUCC. (*H. scandens* MAXIM.) (*Tsuru-ajisai*).

Prov. Iburi:—Rebunge-tôge (Aug. 17, 1890, K. MIYABE). Prov. Shiribeshi:—Akaiwa (Otaru) (Aug. 7, 1924, m.); Zenibako (Oct. 10, 1926, m.). Prov. Ishikari:—Maruyama (June 7, 1921, Y. HOMMA; June 9, 1924; Aug. 19, 1924; Sept. 10, 1922; Sept. 23, 1923; Sept. 25, 1924; Oct. 21, 1924; Oct. 14, 1925, m.); Mt. Moiwa (June 8, 1924; June 10, 1925; July 3, 1924; Aug. 13, 1924; 13, Sept. 4, 1924; Oct. 1924; Nov. 5, 1923, m.); Ishiyama (Sept. 15, 1907, S. Itô); Mt. Teine (Sept. 9, 1921, Y. HOMMA; Sept. 27, 1925, m.); Mt. Kuro-dake (Aug. 19, 1925, K. MIYABE & Naohide HIRATSUKA).

28. *Pucciniastrum Coryli* KOMAROV in JACZEWSKI, KOMAROV et TRANZSCHEL, Fg. Ross. exs. No. 275, 1899—SACC. Syll. p. 320—SYD. Monogr. Ured. III, p. 454, tab. XIX, fig. 161, 1915.

HAB. On leaves of *Corylus rostrata* AIT. var. *mandshurica* REGEL (*Ôba-tsunohashibami*).

Prov. Ishikari:—Sapporo (Nov. 3, 1924, m.).

29 *Pucciniastrum Goodyerae* ARTHUR in N. Amer. Fl. VII, p. 105, 1907—HIRATS. in Jour. Facul. Agric. Hokkaido Imp. Univ. XXI, p. 26, 1927—LIRO, Ured. Fenn. p. 501, 1908—SYD. Monogr. Ured. III, p. 456, 1915.

HAB. On leaves of *Goodyera Maximowicziana* MAK. (*Akebono-shusuran*).

Prov. Ishikari:—Sôunbetsu (Aug. 4, 1925, m.); Mt. Kuro-dake (Aug. 18, 1925, K. MIYABE & Naohide HIRATSUKA).

Thekospora P. MAGNUS

30. *Thekopsora guttata* (SCHRÖT.) SYDOW Monogr. Ured. III, p. 467, 1915—HIRATS. in Transact. Sapporo Nat. Hist. Soc. IX, p. 235, 1927.

SYN. *Melampsora guttata* SCHRÖT. in Abhandl. Schles. Ges. f. vaterl. Kultur. Abt. f. Naturw. 1869/72, p. 26, 1872.

HAB. On leaves of *Galium trifloriforme* KOM. (*Kuruma-mugura*).

Prov. Ishikari:—Mt. Kuro-dake (Aug. 18, 1925; Sept. 12, 1925; Sept. 12, 1926, m.); Nopporo (Sept. 26, 1926, Y. HOMMA). Prov.

Tokachi :—Pankekinaushi (Kuttari) (Oct. 17, 1925, M. OKAMOTO). Prov. Kushiro :—Bokke (Akan) (Sept. 14, 1925, m.).

31. *Thekopsora Rubiae* KOMAROV in JACZWSKI, KOMAROV et TRANZSCHEL, Fg. Ross. exs. no. 328, 1899—SACC. Syll. XVI, p. 321—SYD. Monogr. Ured. III, p. 468, 1915.

HAB. On leaves of *Rubia cordifolia* L. var. *Mungista* MIQ. (*Akane*). Prov. Oshima :—Yesashi (Oct. 27, 1922, m.).

32. *Thekopsora Menziesiae* HIRATSUKA in Jour. Facul. Agric. Hokkaido Imp. Univ. XXI, p. 22, 1927. (HIRATS. in Transact. Sapporo Nat. Hist. Soc. IX, p. 236, 1927).

HAB. On leaves of *Menziesia pentandra* MAXIM. (*Ko-yôraku-tsutsuji*).

Prov. Ishikari :—Mt. Teine (Sept. 27, 1925, m.). Prov. Kushiro :—Mt. Meakan (Sept. 15, 1925, m.).

33. *Thekopsora sparsa* (WINT.) P. MAGNUS Pilze von Tirol, Vorarlberg u. Liechtenstein, p. 118, 1905—FRAG. Fl. Ibér. Ured. II, p. 269, fig. 133, 1925—HIRATS. in Jour. Facul. Agric. Hokkaido Imp. Univ. XXI, p. 24, 1927—SYD. Monogr. Ured. III, p. 464, tab. XX, fig. 162, 1915.

SYN. *Melampsora sparsa* WINT. in Pilze Deutschl. I, p. 245, 1881.

HAB. On leaves of *Arctous japonicus* NAKAI (*Kuma-kokemomo*).

Prov. Ishikari :—Mt. Kuro-dake (Taisetsu-zan) (Sept. 11, 1926, m.).

34. *Thekopsora Tripetaleiae* HIRATSUKA in Jour. Facul. Agric. Hokkaido Imp. Univ. XXI, p. 23, 1927.

HAB. On leaves of *Tripetaleia bracteata* MAXIM. (*Miyama-hotsutsuji*).

Prov. Oshima :—Ônuma (Oct. 29, 1922, m.). Prov. Ishikari :—Mt. Kuro-dake (Sept. 12, 1926, m.).

On leaves of *Tripetaleia paniculata* SIEB. et ZUCC. (*Hotsutsuji*).

Prov. Hidaka :—Samani (April 29, 1900, T. KAWAKAMI).

35. *Thekopsora myrtillina* KARSTEN Myc. Fenn. IV, p. 59, 1879—HIRATS. in Jour. Facul. Agric. Hokkaido Imp. Univ. XXI, p. 19, 1927. (HIRATS. in Transact. Sapporo Nat. Hist. Soc. IX, p. 236, 1927).

HAB. On leaves of *Vaccinium Chamissonis* BONG. (*Yezo-kuro-usugo*).

Prov. Kushiro :—Mt. Meakan (Aug. 22, 1926 ; Sept. 14, 1925, m.) ; Mt. Oakan (Sept. 10, 1925, m.).

On leaves of *Vaccinium uliginosum* L. (*Kuro-mamenoki*).

Prov. Ishikari :—Kumonotaira (Taisetsu-zan) (Sept. 10, 1926, m.).

36. *Thekopsora Vacciniorum* KARSTEN Myc. Fenn. IV, p. 58, 1879—BUBÁK, Rostpilze Böhmens, p. 188, 1908, p.p.—FRAG. Fl. Ibér. Ured. II, p. 132, 1925, p.p.—GROVE, Brit. Rust Fungi, p. 371, 1913, p.p.—HIRATS. in Jour. Facul. Agric. Hokkaido Imp. Univ. XXI, p. 20, 1927—SYD. Monogr. Ured. III, p. 462, 1915, p.p. (HIRATS. in Transact. Sapporo Nat. Hist. Soc. IX, p. 236, 1927—TOGASHI in Jap. Jour. Bot. II, p. 83, 1924).

HAB. On leaves of *Vaccinium Vitis-Idaea* L. (*Kokemomo*).

Prov. Iburi :—Noboribetsu (Oct. 12, 1923, T. NAKAYAMA). Prov. Ishikari :—Mt. Sapporo (Sept. 23, 1922, m.) ; Mt. Karanuma (Sept. 17, 1922, T. ASUHA) ; Kumonotaira (Taisetsu-zan) (Sept. 11, 1926, m.). Prov. Kitami :—Momoiwa (Rebun) (Oct. 12, 1923, K. TOGASHI). Prov. Kushiro :—Mt. Oakan (Aug. 21, 1926, m.).

37. *Thekopsora areolata* (FR.) P. MAGNUS in Sitzungsber. d. Ges. Naturf. Freunde zu Berlin, p. 58, 1875—HIRATS. in Jour. Facul. Agric. Hokkaido Imp. Univ. XXI, p. 14, 1927—SACC. Syll. VII, p. 764—SYD. Monogr. Ured. III, p. 459, 1915. (HIRATS. in Transact. Sapporo Nat. Hist. Soc. IX, p. 235, 1927—SYD. in Ann. Myc. XI, p. 110, 1913).

SYN. *Sclerotium areolatum* FR. Syst. Myc. II, p. 163, 1822.

HAB. On leaves of *Prunus Padus* L. (*Yezo-no-uwamizuzakura*).

Prov. Ishikari :—Sapporo (Oct. 14, 1913, K. MIYABE) ; Maruyama (Oct. 13, 1895, Y. TOKUBUCHI).

On leaves of *Prunus Ssiori* FR. SCHM. (*Shûri-zakura*).

Prov. Iburi :—Chitose (Sept. 1, 1896, K. MIYABE ; Oct. 12, 1900, G. YAMADA). Prov. Shiribeshi :—Inaho-tôge (Oct. 7, 1901, G. YAMADA).

Prov. Ishikari :—Sapporo (Sept. 9, 1895, Naoharu HIRATSUKA ; Oct. 4, 1896, K. MIYABE ; Oct. 10, 1895, K. MIYABE & Y. TOKUBUCHI) ; Maruyama (Oct. 4, 1895, K. MIYABE ; Nov. 14, 1925, m.) ; Mt. Moiwa (Aug. 26, 1896, K. MIYABE) ; Jôzankei (Oct. 17, 1909, M. MIYABE) ; Mt. Kurodake (Sept. 13, 1926, m.). Prov. Kushiro :—Mt. Meakan (Sept. 14, 1925, m.).

38. *Thekopsora Pseudo-Cerasi* HIRATSUKA in Jour. Facul. Agric. Hokkaido Imp. Univ. XXI, p. 16, 1927.

HAB. On leaves of *Prunus serrulata* LINDL. var. *sachalinensis* MAK. (Yezo-yamazakura).

Prov. Ishikari :—Sapporo (Sept. 25, 1896, Naoharu HIRATSUKA ; Sept. 1900, G. YAMADA ; Oct. 1896, Y. TOKUBUCHI ; Oct. 21, 1899, K. MIYABE ; Oct. 30, 1894, Y. TAKAHASHI & Naoharu HIRATSUKA).

On leaves of *Prunus Cerasus* L. (*Seiyô-mizakura*) (cult.).

Prov. Ishikari :—Sapporo (Sept. 17, 1896 ; Sept. 10, 1895, K. MIYABE ; Sept. 25, 1896, Naoharu HIRATSUKA ; Oct. 17, 1897, Y. TOKUBUCHI ; Sept. 20, 1922, m.) ; Maruyama (Sept. 23, 1923, m. ; Oct. 30, 1920, Y. HOMMA) ; Kotoni (Sept. 16, 1896 ; Nov. 10, 1926, Naoharu HIRATSUKA) ; Jôzankei (Sept. 23, 1925 ; Nov. 7, 1926, m.).

Calyptospora KÜHN

39. *Calyptospora Goeppertiana* KÜHN in Hedw. VIII, p. 81, 1869—BUBÁK, Rostpilze Böhmens, p. 189, fig. 46, 1908—GROVE, Brit. Rust Fungi, p. 372, fig. 278, 1913—SACC. Syll. VII, p. 766—SYD. Monogr. Ured. III, p. 470, tab. XX, fig. 163, 1915. (HIRATS. in Transact. Sapporo Nat. Hist. Soc. IX, p. 233, 1927).

HAB. On stems of *Vaccinium Vitis-Idaea* L. (*Kokemomo*).

Prov. Kushiro :—Mt. Oakan (Aug. 21, 1926 ; Sept. 10, 1925, m.).

Hyalopsora P. MAGUS

40. *Hyalopsora filicum* DIETEL in ENGL. Bot. Jahrb. XXXVII, p. 105, 1905—SYD. Monogr. Ured. III, p. 498, 1915

HAB. On leaves of *Dryopteris africana* C. CHR. (*Mizo-shida*).

Prov. Oshima :—Mt. Komagatake (Sept. 28, 1924, m.). Prov. Ishikari :—Mt. Moiwa (July 31, 1925, m.) ; Nopporo (July 12, 1924, m.).

41. *Hyalopsora Polypodii* (DIET.) P. MAGNUS in Ber. Deutschl. bot. Ges. XIX, p. 582, 1901—ARTH. in N. Amer. Fl. VII, p. 112, 1907—BUBÁK, Rostpilze Böhmens, p. 191, 1908—FISCH. Ured. Schw. p. 474, fig. 309, 1904—GROVE, Brit. Rust Fungi, p. 375, fig. 280, 1913—SYD. Monogr. Ured. III, p. 496, 1915—TROT. Fl. Ital. Crypt. Ured. p. 390, 1914.

SYN. *Pucciniastrum Polypodii* DIET. in Hedw. XXXVIII, p. (260), 1899.

HAB. On leaves of *Cystopteris fragilis* BERNH. (*Nayo-shida*).

Prov. Nemuro :—Nemuro (July 12, 1925, m.).

REMARKS :—This species is new to our flora. Our specimen has only its uredo-stage. It is recorded that two kinds of uredospore-forms are present in its life cycle and one of them has thickened walled form with the scattered 6–8 germ-pores and the other rather thin-walled with equatorial germ-pores. But, our specimen has the former form only and its character is as follows :—Uredosori hypophyllous, minute, scattered, yellow ; uredospores globose, ellipsoid or somewhat polygonal, $25.2\text{--}36.0 \times 19.8\text{--}27.0 \mu$, epispore $1.8\text{--}3.6 \mu$ thick, with very faint warts, germ-pores 6 to 8.

Uredinopsis P. MAGNUS

42. *Uredinopsis Adianti* KOMAROV in JACZEWSKI, KOMAROV et TRANZSCHER, Fg. Ross. exs. no. 278, 1899—SACC. Syll. XVI, p. 271—SYD. Monogr. Ured. III, p. 492, 1915.

HAB. On leaves of *Adiantum pedatum* L. (*Kujaku-shida*).

Prov. Ishikari :—Jôzankei (Nov. 10, 1922, Naoharu HIRATSUKA).

REMARKS :—This species is also new to the mycological flora of Japan, and the general character of our fungus is as follows :—Uredosori hypophyllous, small, scattered, yellowish brown, surrounded by a delicate pseudoperidium ; uredospores ovate-fusiform or fusiform, colourless, $27.0\text{--}37.8 \times 10.8\text{--}18.0 \mu$; epispore ca. 1μ ; teleutospores scattered singly throughout the mesophyll, globose or oblong, 2–4

celled, $18.0-30.4 \times 16.2-28.8 \mu$; epispore rather thin, colourless, smooth.

43. *Uredinopsis filicina* P. MAGNUS in Atti Congr. Bot. Internat. d. Genova (1892), p. 167, tab. IX, fig. 1-13, 1893—BUBÁK, Rostpilze Böhmens, p. 192, fig. 48, 1908—FISCH. Ured. Schw. p. 475, fig. 310, 311, 1904—GROVE, Brit. Rust Fungi, p. 379, fig. 284, 1913—SYD. Monogr. Ured. III, p. 484, 1915—TROTT. Fl. Ital. Crypt. Ured. p. 391, fig. 99, 1914. (HIRATS. in Transact. Sapporo Nat. Hist. Soc. IX, p. 236, 1927—TOGASHI in Jap. Jour. Bot. II, p. 83, 1924).

HAB. On leaves of *Dryopteris Phlegopteris* C. CHR. (*Miyamawarabi*).

Prov. Ishikari:—Sapporo (July 15, 1900, G. YAMADA; Aug. 10, 1900, Naoharu HIRATSUKA). Prov. Kushiro:—Mt. Meakan (Sept. 14, 1925, m.); Mt. Oakan (Sept. 10, 1925, m.).

44. *Uredinopsis Pteridis* DIETEL et HOLWAY in Ber. Deutsch. bot. Ges. XIII, p. 331, tab. XXVI, fig. 10, 11, 1895—ARTH. in N. Amer. Fl. VII, p. 116, 1907,—SACC. Syll. XVI, p. 271—SYD. Monogr. III, p. 490, tab. XXII, fig. 166, 1915. (TOGASHI & HIRATS. in Jour. Soc. Agric. & Forest. Sapporo, XVI, p. 76, 1924).

HAB. On leaves of *Pteridium aquilinum* KÜHN (*Warabi*).

Prov. Oshima:—Mt. Komagatake (Sept. 28, 1924, m.). Prov. Shiribeshi:—Zenibako (Oct. 17, 1925, m.); Otaru (Aug. 15, 1900, Naoharu HIRATSUKA). Prov. Ishikari:—Maruyama (Sept. 23, 1923; Sept. 25, 1924, m.); Mt. Moiwa (Sept. 24, 1925, m.); Makomanai (Oct. 23, 1925, m.); Mt. Teine (Sept. 21, 1924; Oct. 5, 1924, m.); Jôzankei (Oct. 16, 1924, m.). Prov. Kitami:—Noshappu-saki (Wakkanai) (Oct. 15, 1923, m.). Prov. Kushiro:—Kutcharo (Aug. 12, 1923, m.).

45. *Uredinopsis Struthiopteridis* STÖRMER in Bot. Notiser (1895), p. 81, 1895—ARTH. in N. Amer. Fl. VII, p. 116, 1907—SACC. Syll. XIV, p. 290—SYD. Monogr. Ured. III, p. 485, tab. XXI, fig. 165, 1915. (HIRATS. in Transact. Sapporo Nat. Hist. Soc. IX, p. 236, 1927—SYD. in Ann. Myc. XI, p. 110, 1913).

HAB. On leaves of *Matteuccia Struthiopteris* (L.) TODARO (*Kusasotetsu*).

Prov. Oshima :—Mt. Komagatake (Sept. 28, 1924, m.). Prov. Shiribeshi :—Zenibako (Nov. 1, 1925, m.). Prov. Ishikari :—Sapporo (Sept. 21, 1924, m.); Garugawa (Sept. 21, 1924, m.); Mt. Teine (Sept. 21, 1924; Oct. 5, 1924; Nov. 1, 1925, m.); Jôzankei (Sept. 23, 1925, m.). Prov. Kushiro :—Rubeshibe (Sept. 8, 1925, m.).

Milesina P. MAGNUS

46. *Milesina Scolopendrii* JAAP in Fungi select. exs. no. 571, 1912—SYD. Monogr. Ured. III, p. 480, 1915. (SYD. in Ann. Myc. XI, p. 110, 1913).

HAB. On leaves of *Phyllitis Scolopendrium* NEWM. (*Ko-taniwatari*).

Prov. Shiribeshi :—Zenibako (Oct. 12, 1924, m.). Prov. Ishikari :—Maruyama (June 13, 1925; Aug. 3, 1924; Aug. 29, 1924; Sept. 25, 1924; Oct. 11, 1924, m.; Sept. 16, 1924, Y. HOMMA); Bannosawa (Kotoni) (Aug. 19, 1924, m.); Mt. Moiwa (Oct. 7, 1925, m.); Mt. Teine (June 17, 1925, m.); Jôzankei (Oct. 17, 1909, M. MIURA).

REMARKS :—The teleuto-stage of this species has never been described. But, the author was able to observe that stage in the specimens collected in the spring of 1925 at Maruyama and Mt. Teine near Sapporo. The character of the teleutospores is as follows :—Teleutosori hypophyllous, often covering the whole surface of the leaves, whitish yellow to pale yellow, intracellular; teleutospores in the epidermal cells, solitary or grouped, ellipsoid or somewhat polygonal, divided into 2 to 4 cells, $19.8-37.8 \times 18.0-27.0 \mu$; episporium hyaline, smooth.

SUBFAM. IV. CHRYSOMYXAE

Chrysomyxa UNGER

47. *Chrysomyxa Pirolae* ROSTRUP in Bot. Centralbl. V, p. 127, 1881—BUBÁK, Rostpilze Böhmens, p. 173, 1908—FISCH. Ured. Schw. p. 429, fig. 327, 1904—GROVE, Brit. Rust Fungi, p. 312, fig. 236, 237, 1913—HIRATS. in Jour. Facul. Agric. Hokkaido Imp. Univ. XXI, p. 36, 1927—SYD. Monogr. Ured. III, p. 516, 1915—TROT. Fl. Ital. Crypt. Ured. p. 358, 1914. (HIRATS. in Transact. Sapporo Nat. Hist. Soc. IX, p. 234, 1927).

HAB. On leaves and petioles of *Pirola renifolia* MAXIM. (*Jinyô-ichiyakusô*).

Prov. Ishikari : Sapporo (May 6, 1890, K. MIYABE); Nopporo (May 8, 1920; May 18, 1922, K. TOGASHI; June 16, 1923, Y. HOMMA; May 17, 1926; June 22, 1923, m.). Prov. Iburi : Lake-side of Shikotsu (June 5, 1927, T. ISHIYAMA, S. IWADARE & M. NAGAI). Prov. Kushiro :—Mt. Meakan (July 25, 1922, m.).

On leaves of *Pirola media* SW. (*Maruba-no-ichiyakusô*).

Prov. Tokachi :—Mt. Nupukaushi (June 6, 1925, m.).

48. *Chrysomyxa Ramischiae* LAGERHEIM in Svensk Bot. Tidskr. III, p. 26, fig. 1, 3, 1909—SACC. Syll. XXI, p. 717—SYD. Monogr. Ured. III, p. 518, 1915.

HAB. On leaves of *Pirola secunda* L. (*Yama-ichiyakusô*).

Prov. Tokachi :—Lake-side of Shikaribetsu-numa (June 6, 1925, m.).

REMARKS :—This species differs from the related species, *Chrysomyxa Pirolae* ROSTR. by having two stages of uredospores, the primary and secondary ones. The present specimen bears the primary uredosori only. This fungus is a new addition to the mycological flora of our country.

49. *Chrysomyxa Cassandrae* TRANZSCHER in Trudi St. Petersb. Obshch. Est. Otd. Bot. XXIII, p. 28, 1893—HIRATS. in Jour. Facul. Agric. Hokkaido Imp. Univ. XXI, p. 33, 1927—LIRO, Ured. Fenn. p. 465, 1908—SACC. Syll. XVII, p. 397—SYD. Monogr. Ured. III, p. 513, 1915.

HAB. On leaves of *Chamaedaphne calyculata* (L.) MOENCH. (*Horomui-tsutsuji*).

Prov. Ishikari :—Horomui (June 20, 1922, m.).

50. *Chrysomyxa expansa* DIETEL in ENGL. Bot. Jahrb. XVIII, p. 287, 1900—MIYABE in Bot. Mag. Tokyo, XXIX, p. 258, 1915—SACC. Syll. XVI, p. 319—SYD. Monogr. Ured. III, p. 512, 1915. (HIRATS. in Transact. Sapporo Nat. Hist. Soc. IX, p. 234, 1927—TOGASHI in Jap. Jour. Bot. II, p. 81, 1924).

HAB. On leaves of *Rhododendron brachycarpum* D. DON. var. *typicum* NAKAI (*Shiobana-shakunage*).

Prov. Ishikari :—Kanayama (May 10, 1917, M. TOCHINAI); Ochiai (July 28, 1912, K. MIYABE); Kushinai (June 20, 1907, Naoharu HIRATSUKA; July 18, 1926, m.). Prov. Kushiro :—Mt. Meakan (July 31, 1897, T. KAWAKAMI; July 25, 1922, m. July 19, 1921, K. TOGASHI.)

On leaves of *Rhododendron chrysanthum* PALL. (*Kibana-shakunage*).

Prov. Shiribeshi :—Mt. Makkari-nupuri (July 27, 1925, Ise). Prov. Ishikari :—Mt. Sapporo (April 20, 1924; June 17, 1923, m.; June 25, 1914, B. ISHIDA); Mt. Kuro-dake (Aug. 4, 1925, m.); Mt. Yeboshi (Taisetsu-zan) (Aug. 5, 1925, m.); Kumonotaira (Taisetsu-zan) (Aug. 4, 1925; July 27, 1926, m.); Mt. Hakuun-dake (Aug. 5, 1925, m.).

51. *Chrysomyxa Ledi* DE BARY in Bot. Zeitg. XXXVII, p. 809, tab. X, fig. 7, 8, 1879—BUBÁK, Rostpilze Böhmens, p. 172, 1908—HIRATS. in Jour. Facul. Agric. Hokkaido Imp. Univ. XXI, p. 34, 1927—LIRO, Ured. Fenn. p. 459, 1908—SACC. Syll. VII, p. 760—SCHRÖT. Pilze Schles. I, p. 371, 1887—SYD. Monogr. Ured. III, p. 504, 1915—WINT. in Pilze Deutschl. I, p. 251, 1881.

HAB. On leaves of *Ledum palustre* L. var. *dilatatum* WAHL. (*Kabafuto-isotsutsuji*).

Prov. Tokachi :—Mt. Nupukaushi (June 6, 1925, m.). Prov. Kushiro :—Mt. Meakan (July 19, 1921, K. TOGASHI). Prov. Nemuro :—Ochiishi-mura (July 16, 1924, m.).

On leaves of *Ledum palustre* L. var. *nipponicum* NAKAI (*Isotsutsuji*).

Prov. Ishikari :—Horomui (June 14, 1925, m.; Sept. 10, 1923, m.).

On leaves of *Ledum palustre* L. var. *yessoense* NAKAI (*Yezo-isotsutsuji*).

Prov. Iburi :—Noboribetsu (Sept. 3, 1910, K. MIYABE). Prov. Ishikari :—Mt. Kuro-dake (Aug. 5, 1925, m.).

52. *Chrysomyxa ledicola* LAGERHEIM in Tromsø Mus. Aarsh. XVI, p. 119, 1893—HIRATS. in Jour. Facul. Agric. Hokkaido Imp. Univ. XXI, p. 35, 1927—SYD. Monogr. Ured. III, p. 507, 1915.

HAB. On leaves of *Ledum palustre* L. var. *procumbens* AIT. (*Hime-isotsutsuji*).

Prov. Ishikari :—Mt. Hokkai-dake (Taisetsu-zan) (Aug. 4, 1925, m.); Mt. Kuro-dake (July 28, 1926; Aug. 4, 1925, m.); Kumonotaira (Taisetsu-zan) (July 28, 1926, m.).

53. *Chrysomyxa Rhododendri* DE BARY in Bot. Zeitg. XXXVII, p. 809, tab. X, fig. 1-6, 1879—BUBÁK, Rostpilze Böhmens, p. 171, fig. 39, 1908—FISCH. Ured. Schw. p. 426, 1904—GROVE, Brit. Rust Fungi, p. 384, 1913—SACC. Syll. VII, p. 760—SYD. Monogr. Ured. III, p. 508, tab. XXIII, fig. 168, 1915—TROTT. Fl. Ital. Crypt. Ured. p. 359, fig. 87, 1914.

HAB. On leaves of *Rhododendron dauricum* L. (*Yezo-murasaki-tsutsuji*).

Prov. Iburi :—Mukawa (Aug. 27, 1895, S. ENDÔ). Prov. Hidaka :—Mt. Apoi (Aug. 17, 1912, K. KONDÔ). Prov. Nemuro :—Ochiishi (July 17, 1924, m.).

REMARKS :—Our specimen has only the uredo-stage. Consequently, it is somewhat difficult to identify its species. However, the character of the uredospores coincides very well with the European specimen of *Chrysomyxa Rhododendri* DE BARY.

54. *Chrysomyxa Empetri* SCHRÖTER in Krypt. Fl. Schles. III, 1, p. 372, 1887—GROVE, Brit. Rust Fungi, p. 311, fig. 235, 1913—HIRATS. in Jour. Facul. Agric. Hokkaido Imp. Univ. XXI, p. 33, 1927—LIRO, Ured. Fenn. p. 454, 1908—FLOWR. Monogr. Ured. p. 253, 1889—SYD. Monogr. Ured. III, p. 515, 1915—TROTT. Fl. Ital. Crypt. Ured. p. 360, 1914. (HIRATS. in Transact. Sapporo Nat. Hist. Soc. IX, p. 234, 1927).

HAB. On leaves of *Empetrum nigrum* L. (*Gankôran*).

Prov. Ishikari :—Mt. Kuro-dake (July 28, 1926, m.). Prov. Tokachi :—Shikaribetsu-numa (July 7, 1925, m.). Prov. Kushiro :—Mt. Meakan (July 19, 1921, K. TOGASHI); Mt. Oakan (Aug. 10, 1923, m.). Prov. Nemuro :—Nemuro (July 12, 1925; July 19, 1924, m.).

55. *Chrysomyxa Abietis* (WALLR.) UNGER in Beitr. zur vergleich. Path. p. 24, 1840—BUBÁK, Rostpilze Böhmens, p. 174, 1908—FISCH. Ured. Schw. p. 429, 1904—HIRATS. in Jour. Facul. Agric. Hokkaido Imp. Univ. XXI, p. 32, 1927—LIRO, Ured. Fenn. p. 452, 1908—SACC. Syll. VII, p. 762—SYD. Monogr. Ured. III, p. 519, 1915—TROTT. Fl. Ital. Crypt. Ured. p. 360, 1914—WEIR in Mycologia, XV, p. 183, 1923.

SYN. *Blennoria Abietis* WALLR. in Allgem. Forst.-u. Jagdzeitg. XVII, p. 65, 1834.

HAB. On leaves of *Picea Glehni* MASTERS (*Aka-yezomatsu*).

Prov. Ishikari :—Nopporo (March 5, 1918, NISHIMURA).

On leaves of *Picea jezoensis* CARR. (*Yezo-matsu*).

Prov. Iburi :—Shimukappu-mura (June 8, 1922, N. NAGANE) ; Lake-side of Shikotsu (June 5, 1927, T. ISHIYAMA, S. IWADARE & M. NAGAI).

On leaves of *Picea excelsa* LINK (*Doitsu-tôhi*) (*cult.*).

Prov. Ishikari :—Sapporo (May, 1924, S. Itô).

SUBFAM. V. CRONARTIEAE.

Cronartium FRIES

56. *Cronartium ribicola* FISCHER DE WALDH. in Hedw. XI, p. 182, 1872—ARTH. in N. Amer. Fl. VII, p. 122, 1907—GROVE, Brit. Rust Fungi. p. 316, fig. 240, 1913—SYD. Monogr. Ured. III, p. 567, 1915. (TOGASHI in Jap. Jour. Bot. II, p. 82, 1924).

HAB. On leaves of *Ribes rubrum* L. (*Aka-suguri*) (*cult.*).

Prov. Ishikari :—Sapporo (Sept. 16, 1905, Y. TAKAHASHI).

On leaves of *Ribes sachalinensis* NAKAI (*Toga-suguri*).

Prov. Kitami :—Uennai (Aug. 10, 1922, K. TOGASHI).

57. *Cronartium flaccidum* (ALB. et SCHW.) WINTER in Pilze Deutschl. I, p. 236, 1881—LIRO, Ured. Fenn. p. 449, 1908—SACC. Syll. VII, p. 598—SYD. Monogr. Ured. III, p. 560, 1915.

SYN. *Sphaeria flaccida* ALB. et SCHW. Consp. Fung. Nisk. p. 31, 1805.

HAB. On branches and stems of *Pinus densiflora* SIEB. et ZUCC. (*Aka-matsu*).

Prov. Ishikari :—Sapporo (June 7, 1924, m.).

On leaves of *Paeonia albiflora* PALL. (*Shakuyaku*) (*cult.*).

Prov. Ishikari :—Sapporo (July 13, 1924 ; Aug. 17, 1924 ; Sept. 7, 1922 ; Sept. 10, 1922, m. ; Aug. 15, 1920, K. TOGASHI) ; Maruyama (Sept. 23, 1923, Naoharu HIRATSUKA).

58. *Cronartium Quercuum* MIYABE in Bot. Mag. Tokyo, XIII, p. 74, tab. IV, V, 1899—GROVE, Brit. Rust Fungi, p. 315, fig. 239, 1913—SYD. Monogr. Ured. III, p. 573, 1915.

HAB. On branches and stems of *Pinus densiflora* SIEB. et ZUCC. (*Aka-matsu*).

Prov. Ishikari :—Maruyama (May 16, 1927, m.).

On leaves of *Quercus crispula* BL. (*Mizu-nara*).

Prov. Ishikari :—Sapporo (Oct. 1895, K. MIYABE ; June 6, 1927, m.).

On leaves of *Quercus dentata* THUNB. (*Kashiwa*).

Prov. Ishikari :—Sapporo (June 6, 1927, m.).

On leaves of *Quercus glandulifera* BL. (*Ko-nara*).

Prov. Ishikari :—Sapporo (Oct. 1, 1896, Naoharu HIRATSUKA) ; Tsukisappu (Oct. 1896, Y. TOKUBUCHI),

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<i>Matteuccia Struthiopteris</i> (L.) TODARO .	<i>Uredinopsis Struthiopteridis</i> STÖRM.
<i>Menziesia pentandra</i> FR.	<i>Thekopsora Menziesiae</i> HIRATS.
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<i>Phyllitis Scolopendrium</i> NEWM.	<i>Milesina Scolopendrii</i> JAAP
<i>Picea excelsa</i> LINK	<i>Chrysomyxa Abietis</i> (WALLR.) UNGER.
<i>P. jezoënsis</i> CARR.	{ <i>Ch. Abietis</i> (WALLR.) UNGER <i>Ch. expansa</i> DIET.
<i>Pinus densiflora</i> SIEB. et ZUCC.	{ <i>Cronartium flaccidum</i> (ALB. et SCHW.) WINT. <i>Cr. Quercuum</i> MIYABE
<i>Pirola media</i> SW.	<i>Chrysomyxa Pirolae</i> ROSTR.
<i>P. minor</i> L.	{ <i>Pucciniastrum Pyrolae</i> (KARST.) SCHRÖT.
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<i>P. secunda</i> L. var. <i>vulgaris</i> HERD. . .	{ <i>Chrysomyxa Ramischiae</i> LAGERH. <i>Pucciniastrum Pyrolae</i> (KARST.) SCHRÖT.
<i>Potentilla centigrana</i> MAXIM.	{ <i>P. Potentillae</i> KOM.
<i>P. cryptotaeniae</i> MAXIM.	
<i>P. fragarioides</i> L.	
<i>P. Freyniana</i> BORUM.	
<i>Populus Maximowiczii</i> A. HENRY . . .	{ <i>Melampsora Larici-populina</i> KLEB.
<i>P. nigra</i> L. var. <i>italica</i> DU ROI . . .	
<i>P. Sieboldii</i> MIQ.	<i>M. Magnusiana</i> G. WAGNER
<i>Prunus Cerasus</i> L.	<i>Thekopsora Pseudo-Cerasi</i> HIRATS.
<i>P. Padus</i> L.	<i>Th. areolata</i> (FR.) P. MAGN.
<i>P. serrulata</i> LINDL. var. <i>sachalinensis</i> MAK.	<i>Th. Pseudo-Cerasi</i> HIRATS.
<i>P. Ssiori</i> FR. SCHM.	<i>Th. areolata</i> (FR.) P. MAGN.
<i>Pteridium aquilinum</i> KÜHN	<i>Uredinopsis Pteridis</i> DIET. et HOLW.
<i>Quercus crispula</i> BL.	{ <i>Cronartium Quercuum</i> MIYABE
<i>Q. dentata</i> THUNB.	
<i>Q. glandulifera</i> BL.	
<i>Rhododendron brachycarpum</i> D. DON. var. <i>typicum</i> NAKAI	{ <i>Chrysomyxa expansa</i> DIET.
<i>Rh. brachycarpum</i> D. DON. var. <i>roseum</i> KOIDZ.	
<i>Rh. chrysanthum</i> PALL.	{ <i>Cronartium ribicola</i> FISCH. DE WALDH.
<i>Rh. dauricum</i> L.	
<i>Ribes rubrum</i> L.	{ <i>Thekopsora Rubiae</i> KOM.
<i>R. sachalinensis</i> NAKAI	
<i>Rubia cordata</i> L. var. <i>Mungista</i> MIQ. .	<i>Melampsora yezoensis</i> MIYABE et MATSU-MOTO
<i>Salix jessoensis</i> v. SEEM.	
<i>S. Miyabeana</i> v. SEEM.	{ <i>M. Larici-epitea</i> KLEB.
<i>S. rorida</i> LACK.	
<i>S. sachalinensis</i> FR. SCHM.	

<i>S. Urbaniana</i> v. SEEM.	<i>M. Larici-Urbaniana</i> MATSUMOTO
<i>S. viminalis</i> L. var. <i>yezoensis</i> C.K. SCHN.	<i>M. Larici-epitea</i> KLEB.
<i>Stellaria media</i> CYR. }	<i>Melampsorella Caryophyllacearum</i>
<i>S. yezoense</i> MAXIM. }	SCHRÖT.
<i>Styrax Obassia</i> SIEB. et ZUCC.	<i>Pucciniastrum Styracinum</i> HIRATS.
<i>Tilia japonica</i> SIMK. }	
<i>T. Maximowicziana</i> SHIRASAWA }	<i>P. Tiliae</i> MIYABE
<i>Tripetaleia bracteata</i> MAXIM. }	
<i>T. paniculata</i> SIEB. et ZUCC. }	<i>Thekopsora Tripetaleiae</i> HIRATS.
<i>Vaccinium Chamissonis</i> BONG. }	
<i>V. uliginosum</i> L. }	<i>Th. myrtillina</i> KARST.
<i>V. Vitis-Idaea</i> L.	{ <i>Calyptospora Goeppertiana</i> KÜHN
	{ <i>Thekopsora Vacciniorum</i> KARST.
<i>Viburnum furcatum</i> BL.	<i>Pucciniastrum Miyabeianum</i> HIRATS.

Mikrochemische Untersuchungen des mit Kupfervitriol imprägnierten Holzes von *Cryptomeria japonica* Don.

Von **Kametaro OHARA**

Mit Tafel X

(Eingegangen am 6. Oktober 1927)

1. Einleitung

Dass die in einen Holzkörper injizierte Flüssigkeit der Leitungsbahn des Holzes folgt, ob sie unterm niederen oder hohen Druck injiziert wird, ist dank STRASBURGER⁽¹⁾ seit langem im Kreise der Fachmänner wohl bekannt. Doch blieb es noch unklar, wie die Salze in den Flüssigkeiten, wie Kupfervitriol, Zinkchlorid, u. s. w. im Holz aufgespeichert werden, insbesondere wie sie sich in den Zellmembranen des Holzgewebes fixieren lassen. Ob die oben genannten Salze sich mit den Zellwandstoffen chemisch verbinden oder colloidchemisch adsorbiert werden, ist noch nicht aufgeklärt worden. Nachdem die Kolloidstrukturlehre,⁽²⁾ welche an der Micellartheorie von NÄGELI eine Stütze hat, in diesen Dezennien einen grossen Fortschritt gemacht hat, könnte man diese Forschungsmethoden verwenden, um das erwähnte Problem zu lösen. Doch gibt es eine andere Methode, die von MOLISCH⁽³⁾ unter dem Namen „Aschenbild“ den Botanikern empfohlen wird, wobei es sich um die mikroskopische Beobachtung der Pflanzenasche handelt, die man hierbei verwenden kann. Sie hat mir bei diesen Untersuchungen eine grosse Hilfe geleistet, da die mit anorganischen Salzen imprägnierten Hölzer ein geeignetes Material für die Herstellung von „Aschenbildern“ liefern.

Die vorliegende Arbeit bezweckt nun, nicht nur das Verhalten des injizierten Salzes zur Zellmembran, sondern auch die Verwendbarkeit dieser Methoden auf die Erforschung der Holzimprägnierung nach-

(1) STRASBURGER, E.:—Ueber den Bau u. die Verrichtungen der Leitungsbahnen. Jena 1891. S. 969.

(2) ZSIGMONDY, R.:—Colloidchemie. IV. Aufl. 1925. S. 37.

(3) MOLISCH, H.:—Aschenbild und Pflanzenverwandtschaft. Sitz.-Ber. d. Akad. d. Wiss., mathem.-naturw. Kl., Nr. 129. Wien 1920.

zuweisen, insbesondere ob dadurch neue Tatsachen gefunden werden können.

Als Untersuchungsmaterial benutzte ich eine Telegraphenstange, die aus einer 38-jährigen und ca. 8 Meter langen *Cryptomeria japonica* hergestellt worden war. Am 15. November 1925 wurde der Baum gefällt und in einer Fabrik zu Minomati, Gihuken unter einem Druck von 55 engl. Pfund mit einer speziell für diesen Zweck hergestellten Maschine von der Hirnfläche des Wurzelendes aus imprägniert.⁽¹⁾ Die Kupfervitriollösung enthielt 3,82 g Cu in 100 cc. Vor der Imprägnierung wurde durch das Holz mittels der genannten Maschine ein Luftstrom eine halbe Stunde lang durchgedrückt und dann vom oberen Hirnende eine Probe abgeschnitten. Nachdem dann der Holzstamm 1 Stunde dem Imprägnierungsverfahren ausgesetzt worden war, schnitt man die II. Probe. Dies wiederholte sich nach 4½ Std. und nach 6 Std. Die letzte Probe wurde nach 15 Stunden entnommen. Die Untersuchungen dieser Holzproben fanden erst im Sommer 1927 statt.

2. Die Verbreitung des Kupfers im Holzkörper

Um die Verbreitung des Kupfers im Holzkörper zu erkennen, benutzte ich sowohl die mikrochemische Methode als auch das Aschenbild des Holzes. Für den mikroskopischen Nachweis von Cu wurde die Reaktion, welche auf Entstehung von Cupri-Mercuricyanat ($\text{Cu}(\text{CNS})_2\text{-Hg}(\text{CNS})_2 + \text{H}_2\text{O}$) beruht und von BEHRENS und KLEY⁽²⁾ als sehr empfindliches Reagens empfohlen wird, verwendet. Bei dieser Reaktion trat das oben erwähnte Reaktionsprodukt als winzig kleine, gelbe oder braune Kristalle, manchmal in Sphäroritenform auf. Die Reduzierung des Kupfersalzes durch Hydrazinhydrat,⁽³⁾ ergab ebenfalls ein gutes Resultat, welches die Verbreitung von Cu in den Geweben übersichtlich machte. Nach diesen zwei Methoden konnte keine Kupferreaktion sowohl in den noch nicht als auch in den 1 Stunde lang imprägnierten Holzgeweben nachgewiesen werden. Bei dem über 4½ Stunden lang imprägnierten Holz traten die beiden Reaktionen in den Geweben, wo das Kupfer fixiert war, sehr deutlich auf. Alle Markstrahlzellen im

(1) Das Imprägnierungsverfahren, welches bei diesen Untersuchungen gebraucht wurde, ist dem Herrn IIDA, von dem alle Materialien mir zur Verfügung gestellt wurden, und dem ich für seine Freundlichkeit zum herzlichsten Dank verpflichtet bin, patentiert.

(2) BEHRENS—KLEY:—Mikrochemische Analyse. I. Teil 1921. Leipzig. S. 65.

(3) FREY, A.:—Die Technik der dichroitischen Metallfärbungen. Zts. f. wiss. Mikroskopie. Bd. 42, H. 4, 1926. S. 429—430.

Splintholz waren mit gelben Kriställchen ausgefüllt, während in den Tracheiden des Frühholzes, ja sogar an der Stelle, wo sie mit Markstrahlen in Berührung kamen, nicht oder sehr selten die Kupferreaktion nachgewiesen werden konnte. Im Strangparenchym wurde fast immer das reichliche Vorhandensein von Kupfer nachgewiesen, so dass der Inhalt dieses Gewebes wegen der Reichhaltigkeit an Kupfer manchmal undurchsichtig erschien. Im Gegensatz zu Frühtracheiden, wo die Kupferreaktion nicht deutlich auftrat, waren alle Spätracheiden fast ausnahmslos, manchmal bis zu den Tüpfeln, mit Kupferverbindungen ausgefüllt. Ausserdem waren die Tracheidenwände des Spätholzes tief gelb, diejenigen im Frühholz schwach gelblich gefärbt.

Die oben erwähnten Tatsachen stimmen mit der Annahme STRASBURGERS⁽¹⁾ überein, dass die engen Spätracheiden, insbesondere im Splintholz um den Kern, die Imprägnierung sehr erleichtern, infolge der offen gebliebenen Hoftüpfeln und der weit langsamer fortgeschrittenen Verkernung.

In den noch länger imprägnierten Holzgeweben traten diese Reaktionen noch deutlicher auf, wie Fig. 1 (Taf. X) sehr gut nachweist, wo man besonders die Verbreitung des Cu in den Geweben klar erkennen kann. In den Holzproben, welche mehr als 6 Stunden imprägniert waren, trat die Kupferreaktion nicht nur in den Spätracheiden, sondern auch in den Frühtracheiden, besonders wo sie mit Markstrahlen in Berührung kamen, deutlich auf. Diese Erscheinung beweist, dass das Kupfersalz durch Markstrahlen in die Frühtracheiden transportiert und in der Nähe derselben depositiert worden ist. Dieses Uebersichtsbild gaben die mit Hydrazinhydrat behandelten Gewebe noch deutlicher, in dem die mit Kupfer versehenen Teile grün oder rot erschienen. Ob diese Farbenverschiedenheit auf Teilchengrösse des kolloidalen Kupfers beruht oder von Reduzierungsstufen gekommen ist, bleibt mir noch unklar. Was den Hoftüpfel des Frühholzes anbelangt, so erkennt man durch Cupriccyanat-Reaktion zuweilen die Anhäufung der gelben Kriställchen im Hof, die manchmal gänzlich, manchmal teilweise den Hof ausfüllen. Wenn man die Schnitte des Holzes mit Alkohol behandelt, kommen die Kupfervitriolkristalle an der Mündung des Hofes heraus. Man kann daher annehmen, dass diese Anhäufung des Kupfers im Hof mit den Tracheidenmembranen nichts zu tun hat.

(1) STRASBURGER, E:—l.c. 1891. S. 982.

Was nun die braune Färbung der Zellmembranen bei dieser Reaktion betrifft, so werden wir später davon reden, wenn wir ihre kolloidalen Eigenschaften erörtern werden. Um die Verbreitung des Kupfers im Holzkörper zu erkennen, kann man auch verschiedene Jodreagentien benutzen, da das Jod mit Kupfer zu CuJ verbunden wird. Durch Behandlung der Schnitte mit Jodjodkali werden alle Zellmembranen, insbesondere diejenigen des Spätholzes durch das bei der Reaktion freigelassene J deutlich gelb bis braun gefärbt, während die Pori des Hoftüpfels durchaus ungefärbt bleiben.

Würde man sich nur auf die vorher erwähnten Untersuchungsmethoden beschränken, so müsste man annehmen, wie es bisher angenommen worden ist, dass das Kernholz von der Kupferimprägnierung frei bleibt, trotzdem bei Hervorrufung der Cupriccyanat-Reaktion im Kernholz schwach gelbe Färbung der Zellmembranen auftrat. Zu einem andern Resultat kommt man aber bei Anwendung des „Aschenbildes.“

Was nun das Aschenbild des imprägnierten Holzes von *Cryptomeria* anbelangt, so ist es ein geeignetes Material, da das nicht imprägnierte Holz kein charakteristisches Aschenbild darbietet, während das Kupfersalz immer als Kupferoxyd an Ort und Stelle, wo es depositiert ist, im Aschenbild vorkommt. Wie ich in meiner letzten Arbeit⁽¹⁾ über die Verwendung des Aschenbildes für die Erkennung des Holzes erwähnt habe, wurden die 5–10 mm dicken Spiegel- und Fladerschnitte auf einem Platinplättchen mit kleiner Flamme des BUNSENBrenners vollständig verascht. Manchmal wurde die Methode von SCHOELLER,⁽²⁾ der das Veraschen der Probe in einem Verbrennungsrohr in der Sauerstoffströmung empfiehlt, verwendet. Es ist jedoch besser, um feine Präparate herzustellen, den elektrischen Ofen zu benutzen, da die Probe in diesem Falle von allen Seiten gleichmässig erhitzt werden kann. Ein kleiner Ofen wurde horizontal eingestellt, und die Probe wurde auf einem Platinplättchen in dem Ofen verascht. Die hergestellte Asche wurde dann in Anilinöl eingeschlossen. Manchmal war es notwendig, andere Einschliessmittel zu gebrauchen, z. B. Wasser, Glycerin, Alkohol oder Canadabalsam, da Anilinöl auf Kupfersalz chemisch wirken kann. Wie oben erwähnt, zeigte die Asche des nicht

(1) OHARA, K.:—Ueber die Verwendung des Aschenbildes für die Erkennung technisch wichtiger Hölzer. Denkschrift d. Akad. d. Wiss., mathem.-naturw. Kl., Bd. 100. Wien. 1926. S. 302.

(2) SCHOELLER, A.:—Mikro-Veraschung. Ber. d. D. Chem. G. Jhrg. LV, H. 7. 1922. S. 2191.

oder nur 1 Stunde lang imprägnierten Holzes keine charakteristische Struktur, sondern nur Querstreifungen aus feinkörnigen Kriställchen, die der Markstrahlen in der Rinde und im äussersten Jahresringe entsprechen. Bei den noch weiter imprägnierten Holzproben trat das Kupfer in Form von schwarzen Körnchen auf, welche meistens so angeordnet waren, dass man daraus zwei Seiten der Zellwände erkennen konnte. In den völlig imprägnierten Teilen der Gewebe wiesen die Zellwände keine körnige Struktur auf, sondern erschienen durchaus schwarz, woran man die vollständige Fixierung des Kupfers erkennen konnte.

Es ist von nicht geringerem Interesse, dass die englumigen Spättracheiden des $4\frac{1}{2}$ Stunden lang imprägnierten Holzes als braunfärbige, durchsichtige faserige Gebilde, deren Oberfläche mit schwarzen Körnchen teilweise bedeckt waren, in der Asche auftraten. Nach 1-stündigem Kochen der Schnitte im Wasser und darauf folgendem Veraschen blieben noch diese Gebilde in der Asche, welche im polarisierten Lichte weisse Interferenzfarbe zeigten (Taf. X, Fig. 4, 5). Über diese Gebilde werde ich später reden. In der Asche des über 6 Stunden imprägnierten Holzes erschienen diese Gebilde ganz schwarz, da die reichliche Anhäufung des Kupfers die Durchsichtigkeit der Struktur verhinderte (Fig. 2). Markstrahlzellen waren immer mit schwarzen Körnchen ausgefüllt: hier waren die Körnchen manchmal grösser als diejenigen an den Tracheidenwänden (Fig. 2). In den Geweben des Kernholzes, in denen sich nach den bisher üblichen Methoden keine Kupferreaktion erkennen liess, kamen die oben erwähnten faserigen Gebilde oder Tracheiden- und Markstrahlzellmembranen aus schwarzen Körnchen vor, wenn das genügend imprägnierte Holz verascht wurde (Fig. 7). Obwohl diese Körnchen im Vergleich zu denselben im Splintholz beträchtlich geringer auftraten, gaben sie durch Cupriccyanat-Reaktion ein positives Resultat. Dieses Ergebnis, das das Vorhandensein von Kupfer im Kernholz nachweist, steht im Gegensatz zu der allgemeinen Annahme,⁽¹⁾ dass sich Kernholz nicht imprägnieren lasse, ja nicht einmal unterm hohen Druck. Nachfolgende Tabelle mit der von mir aufgestellten Analyse zeigt das Resultat in genauen Zahlen.

(1) STRASBURGER, E.:—l.c. 1891. S. 971.

BUB-BODMAR u. TILGER:—Die Konservierung des Holzes in Theorie und Praxis. Berlin. 1922. S. 960.

SCHWALBE, C.:—Studien zur Holzkonservierung. I. Zts. f. ang. Chemie. Jhrg. 40. H. 4. 1927.

	Wassergehalt	Aschengehalt	Cu% in d. Asche	Cu% im Holz	Cu% im getrockn. Holz
Splintholz	40.20	1.35	67.15	0.43	0.70
Kernholz	42.76	0.94	19.20	0.082	0.14

3. Die dichroitische Erscheinung der imprägnierten Zellmembranen

AMBRONN⁽¹⁾ hat schon im Jahre 1888 darauf hingewiesen, dass die gefärbten Fasern manchmal einen auffallenden Dichroismus zeigen. Färbt man die Ramiefaser mit Chlorzinkjod und legt man ihre Längsachse parallel zur Polarisationssebene des Nikols, so erscheint sie farblos, dagegen in gekreuzter Stellung schwarz. Es wurde von AMBRONN hervorgehoben, dass diese Erscheinung auf die gerichtete Ablagerung der Farbstoffteilchen in der Zellmembran zurückzuführen ist. Neuerdings wurde diese Untersuchung von seinem Schüler FREY⁽²⁾ auf die Metallfärbung verwendet, und es wurde erwiesen, dass diese Annahme auch in diesem Falle gerechtfertigt war. Es wurde auch von FREY⁽²⁾ erkannt, dass die mit Cu gefärbte Ramiefaser einen positiven Dichroismus zeigt. Die gefärbte Faser erscheint smaragdgrün, wenn sie über den Polarisator parallel zur Schwingungsebene des Nikols gelegt wird, dagegen schmutzigrot im umgekehrten Sinne. Er nahm an, dass es sich bei dieser Erscheinung um „gerichtete“ Adsorption des Kupfers durch Zellmembran handelt.

Wenn dieser Schluss richtig ist, und beim Imprägnieren Adsorption des Kupfersalzes an die Holzzellmembranen vorliegt, so muss diese dichroitische Erscheinung auch bei imprägnierten Holzgeweben beobachtet werden können. Nach der Vorschrift von FREY⁽³⁾ habe ich dünne Schnitte des 15 Stunden lang imprägnierten Holzes in Hydrazinhydrat erhitzt und in Canadabalsam eingeschlossen. Die Schnitte zeigten im auffallenden Lichte eine metallische Kupferfarbe und im durchfallenden Lichte eine grüne Farbe. Es erwies sich, dass die Tracheidenmembranen, insbesondere diejenigen des Spätholzes über

(1) AMBRONN, H.:—Pleochroismus gefärbter Zellmembranen. Ber. d. D. B. G. Bd. VI. H. 2. 1888. S. 87—94.

(2) FREY, E.:—Zur Frage nach der Ursache des Dichroismus gefärbter Fasern. Naturwissenschaften. Jhrg. 13. H. 19. 1925. S. 405.

(3) FREY, E.:—Zts. f. wiss. Mikroskopie. 1926. 1. c. S. 429—430.

den Polarisator einen positiven Dichroismus zeigten. Als ich die Längsachse der Tracheiden zur Schwingungsebene des Nikols parallel legte, erschien die sekundäre oder manchmal die tertiäre Zellmembran der Tracheiden in der schmutzig-grünen Farbe, während sie sich im umgekehrten Sinne rot färbten. Die Mittellamellen blieben immer farblos, oder sie zeigten nirgend einen Farbumschlag. An den Tracheidenwänden hatte sich überall eine tiefgrün gefärbte Substanz, welche keinen Dichroismus zeigte, abgelagert. Die engen Lumen der Spättracheiden waren bis zum Tüpfel mit dieser Substanz ausgefüllt. (Fig. 8) Diese Substanz ist nichts anders als das Kupfersalz, welches sich im Zelllumen befand und durch Hydrazinhydrat reduziert wurde, so dass es zur Zellwandstruktur keine Beziehung hat. Manchmal erkennt man die rot gefärbten Teile in den Geweben, insbesondere in der tertiären Zellmembran. Man beobachtet manchmal in den Hoftüpfeln die schwarzen, aus reduziertem Kupfer bestehenden Körnchen, welche keinen Dichroismus zeigen, da das Kupfer in diesen Hoftüpfeln mit der Zellmembran nichts zu tun hat.

Nach der obigen Ausführung kann es wohl als erwiesen angesehen werden, dass beim Imprägnieren sich die sogenannte „gerichtete Adsorption“ des Kupfers durch Zellmembran abgespielt hat.

4. Das Aschenbild im polarisierten Lichte

Es wurde im vorigen Kapitel erwähnt, dass man viele faserige, im polarisierten Lichte grau bis weiss leuchtende Gebilde in der Asche des imprägnierten Holzes findet. Gleichzeitig wurde es auch hervorgehoben, dass diese Gebilde nach Auskochen der dünnen Schnitte im Wasser noch deutlich hervortreten, während andere Strukturen, wie die Reste des Markstrahlzellinhaltes gänzlich oder teilweise verschwunden sind (Fig. 4, 6). Aus ihren Formen und ihrer Grösse kann man leicht erkennen, dass diese Gebilde meistens aus dem Spätholz gekommen sind. Diese faserigen, gelb bis braun gefärbten Gebilde zeigten meistens die Formen der Spättracheiden, die nebeneinander parallel angeordnet sind. Die Enden der Tracheiden sind manchmal rund, wie diejenigen der intakten Tracheiden, oder manchmal stumpf. Sie messen 5-20 μ im Durchmesser, durchschnittlich 7-15 μ . Markstrahlen aus zwei oder drei Zellen findet man in ihrer originellen Stellung, d. i. quer zur Faserrichtung. Alle diese Gebilde, welche unterm Mikroskop gelb bis braun erscheinen, zeigten auf ihrer Ober-

fläche die feinkörnigen Strukturen, die gewöhnlich parallel zur Längsrichtung der Tracheiden laufen. Manchmal findet man Tracheiden, die aus spiralförmigen Fibrillen bestehen.

Wenn man einen dünnen Schnitt aus dem über $4\frac{1}{2}$ Stunden imprägnierten Holz eine Stunde lang im Wasser kocht und bei 700° – 800° im Ofen verascht, so erkennt man noch im Aschenbild die oben geschilderten Strukturen. Der Inhalt der Tracheiden, d. i. die Anhäufung des Kupfersalzes im Zelllumen ist gänzlich oder teilweise verschwunden. Im Gegensatz zum Aschenbild der nicht ausgekochten Holzschnitte (Fig. 2, 3), in dem die Spätracheiden und Markstrahlzellen mit schwarzem Inhalt versehen sind (Fig. 3), treten die faserigen Strukturen des Spätholzes nebst den leeren Markstrahlzellen noch deutlich hervor (Fig. 4). Wie oben erwähnt, kommen Markstrahlen manchmal als gelbbraune Stäbchen vor. Behandelt man diese Gebilde mit HCl Lösung, so lösen sie sich gänzlich auf, während sie im Wasser ungelöst bleiben. Durch $\text{HgCl}_2 + \text{HN}_4\text{CNS}$ Lösung lösen sich die faserigen Gebilde, und sie lassen zahllose schwarze Körnchen zurück, welche als Ganzes noch den Umriss der Tracheiden aufweisen. Diese Tatsache mit der Reaktion durch Ferrocyankalium im Reagenzglas beweist, dass diese Gebilde hauptsächlich aus Kupfer, welches trotz des Auskochens im Wasser noch reichlich im Holz blieb, bestehen. Die Adsorption des Kupfers ist so stark, dass im Aschenbild der Schnitte, die im Wasser drei Tagen lang nach dem Kochen aufbewahrt wurden, die deutliche Zellstruktur, deren Zellwände aus schwarzem CuO bestehen, beobachtet werden konnte, obgleich die oben erwähnten faserigen Gebilde in diesem Falle verschwunden waren.

Infolgedessen ist das Kupfer, welches durch Imprägnierung im Holz fixiert und gegen Abwaschen beständig ist, nicht dasjenige im Zelllumen, wo es mit verschiedenen Substanzen, wie Proteine, Gerbstoffe u.s.w. chemisch verbunden ist, sondern dasjenige in den Zellmembranen, im Gegensatz zur allgemeinen Annahme.

Was nun das optische Verhalten der faserigen Gebilde im polarisierten Lichte anbelangt, so stimmt es gänzlich mit demjenigen der Spätracheiden in den intakten Geweben überein. Beobachtet man die Tracheidenasche zwischen den gekreuzten Nikols, so leuchtet sie grau bis weiss, und sie erlischt in keiner Stellung. Auf dem Gypsplättchen von Rot I. Ordnung liefert sie meistens unter $+45^{\circ}$ grüne, unter -45° gelbe Farben, während sie unter 0° anstatt rote, violette Farbe und unter 90° gelbe Farbe zeigt, wodurch man erkennt, dass die

Micellaranordnung in der Asche der Tracheiden unter 0° und 90° bez. Alternative- und Consecutivstellung⁽¹⁾ einnimmt.

Wir haben schon kennen gelernt, dass es solche Gebilde gibt, welche die spiralige Struktur zeigen. Wenn man diese Gebilde unterm Polarisationsmikroskop beobachtet, erkennt man, dass die Längsachse der Fibrillen mit ihrer optischen Elasticitätsachse zusammentrifft, so dass sie unter $+45^\circ$ grüne, und unter -45° gelbe Farben liefern. In diesem Falle erscheint die Tracheid als Ganzes unter $+$ und -45° neutral. Manchmal liefert die Tracheidenasche unter 0° gelbe, unter 90° violette Farben, indem die spiralige Struktur in der Zellmembran ganz umgekehrt liegt. Man findet manchmal Gebilde, welche die feine Struktur der intakten Gewebeelemente wiedergeben, so dass man auf den Rändern der Tracheiden das Bild des optischen Durchschnitte der Zellwände beobachten kann. In diesem Falle liefern die Ränder unter $+45^\circ$ gelbe, unter -45° grüne Farben, während sie auf der Flächenansicht unter $+45^\circ$ grüne Farbe zeigen. Es ist daher erwiesen, dass die kleinste Elasticitätsachse radial, die mittlere und die grösste tangential liegt. Diese beiden letzteren sind zur Tracheidenachse etwas geneigt. Die oben erwähnten optischen Erscheinungen stimmen gänzlich mit dem optischen Verhalten der Gewebeelemente im Spätholz von *Cryptomeria japonica* überein, wodurch man erkennt, dass die Micelle im Aschenbild noch genau so angeordnet ist, wie man in den Tracheidenmembranen gefunden hat. Insofern das Verhalten der Elasticitätsachse auf Anordnung der Celluloseeteilchen in der Zellmembran zurückzuführen ist und die faserigen Gebilde hauptsächlich aus adsorbiertem Kupfer bestehen, ist die Annahme gerechtfertigt, dass die oben erwähnten optischen Erscheinungen von der Adsorption des Kupfers an die Celluloseeteilchen gekommen sind. Es liegt der Gedanke nahe, dass die Celluloseeteilchen durch Verbrennen verschwunden sind, und dass an Ort und Stelle, wo sie sich befanden, die Kupferverbindung aufgetreten ist.

Es sei auch hier erwähnt, dass die Ligninreaktion der Holzzellmembran beim Imprägnieren nach wie vor ganz gleich bleibt.

Auf der Oberfläche der faserigen Gebilde, die die oben erwähnten optischen Erscheinungen zeigen, kommen manchmal fleckenartig, unregelmässig angeordnete Teile vor, welche auf unvollständige Adsorption zurückzuführen sind.

(1) DIPPEL :—Das Mikroskop, II. Braunschweig, 1898. S. 247.

Zusammenfassung

1. Es wurde mikrochemisch nachgewiesen, dass die in den Holzkörper von *Cryptomeria japonica* imprägnierte Kupfervitriollösung den Leitungsbahnen folgt.

2. Im Verlaufe der Imprägnierung tritt das genannte Salz zunächst im Spätholz und in den Markstrahlen, dann in den Frühtracheiden, besonders wo sie mit Markstrahlen in Berührung kommen, auf.

3. Für den Nachweis des Kupfers im Holz wurden drei mikrochemische Reaktionen, nämlich die Reduzierung durch Hydrazinhydrat, Jodjodkali- und Cupriccyanat-Reaktionen benutzt, unter denen die letztere die höchste Empfindlichkeit aufwies.

4. Im Aschenbild des Holzes erscheinen Spätracheiden braun oder schwarz, je nach den Imprägnierungsstufen, während Markstrahlen und Frühtracheiden aus schwarzen Linien von CuO bestehen.

5. Nach einstündigem Kochen der dünnen Schnitte des genügend imprägnierten Holzes treten hauptsächlich die Gewebeelemente des Spätholzes in der Asche auf, während nach darauf folgendem Liegenlassen der Schnitte im Wasser nur die aus CuO bestehenden Frühtracheiden- und Markstrahzellwänden in der Asche vorkommen.

6. Aus oben erwähnten Tatsachen kann man ersehen, dass das Kupfer im Zelllumen, wo es mit Inhaltsstoffen chemisch verbunden ist, nicht so beständig ist, wie dasjenige in den Zellwänden.

7. Die "gerichtete Adsorption" des Kupfers durch Zellwände hat sich beim Imprägnieren abgespielt, da die Tracheiden im polarisierten Lichte einen positiven Dichroismus zeigen.

8. Die braun gefärbten Tracheidenreste in der Asche leuchten grau bis weiss im polarisierten Lichte. Sie erscheinen in keiner Stellung neutral, indem sie unter 0° und 90° Subtraktions- bez. Additionsfarben zeigen.

In den Fibrillen der Tracheiden liegt die grösste Elasticitätsachse parallel zu ihrer Längsrichtung.

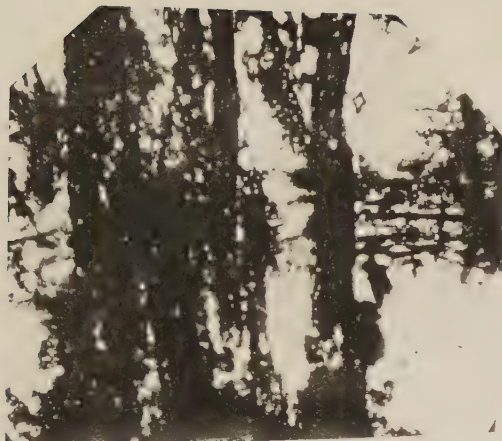
9. Da das optische Verhalten der braun gefärbten Elemente in der Asche mit demjenigen der Spätracheiden in den intakten Geweben übereinstimmt, ist es höchst wahrscheinlich, dass das Kupfer an die Cellulosepartikel in Holzzellwänden adsorbiert wird.

NAGOYA, den 23. August 1927.

Institut für Warenkunde an der
Handelshochschule.

Erklärungen der Tafel X

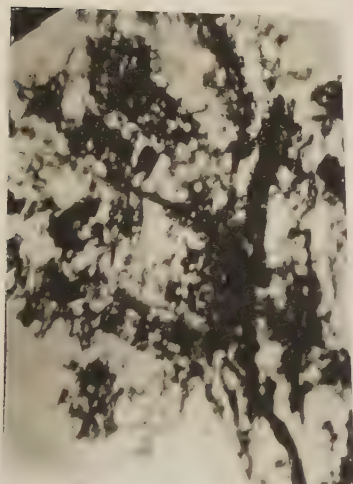
- Fig. 1. Radialer Längsschnitt durch das mit Hydrazinhydrat behandelte Holz, welches 15 Stunden lang imprägniert war. LEITZ IV \times 2.
- Fig. 2. Aschenbild des 15 Stunden lang imprägnierten Holzes. ZEISS II \times D.
- Fig. 3. Aschenbild des 4 $\frac{1}{2}$ Stunden lang imprägnierten Holzes. ZEISS II \times D.
- Fig. 4. Dasselbe nach zweistündigem Kochen im Wasser. REICHERT Polarisationsmikroskop II \times 2.
- Fig. 5. Dasselbe im polarisierten Lichte.
- Fig. 6. Dasselbe mit Markstrahlen. ZEISS 22 m.m. Apochr. \times D.
- Fig. 7. Aschenbild des 15 Stunden lang imprägnierten Kernholzes. ZEISS II \times D.
- Fig. 8. Hoftüpfel mit Kupferablagerung. ZEISS 22 mm. Apochr. \times Komp. Okul.
-



2



1



3



6



4



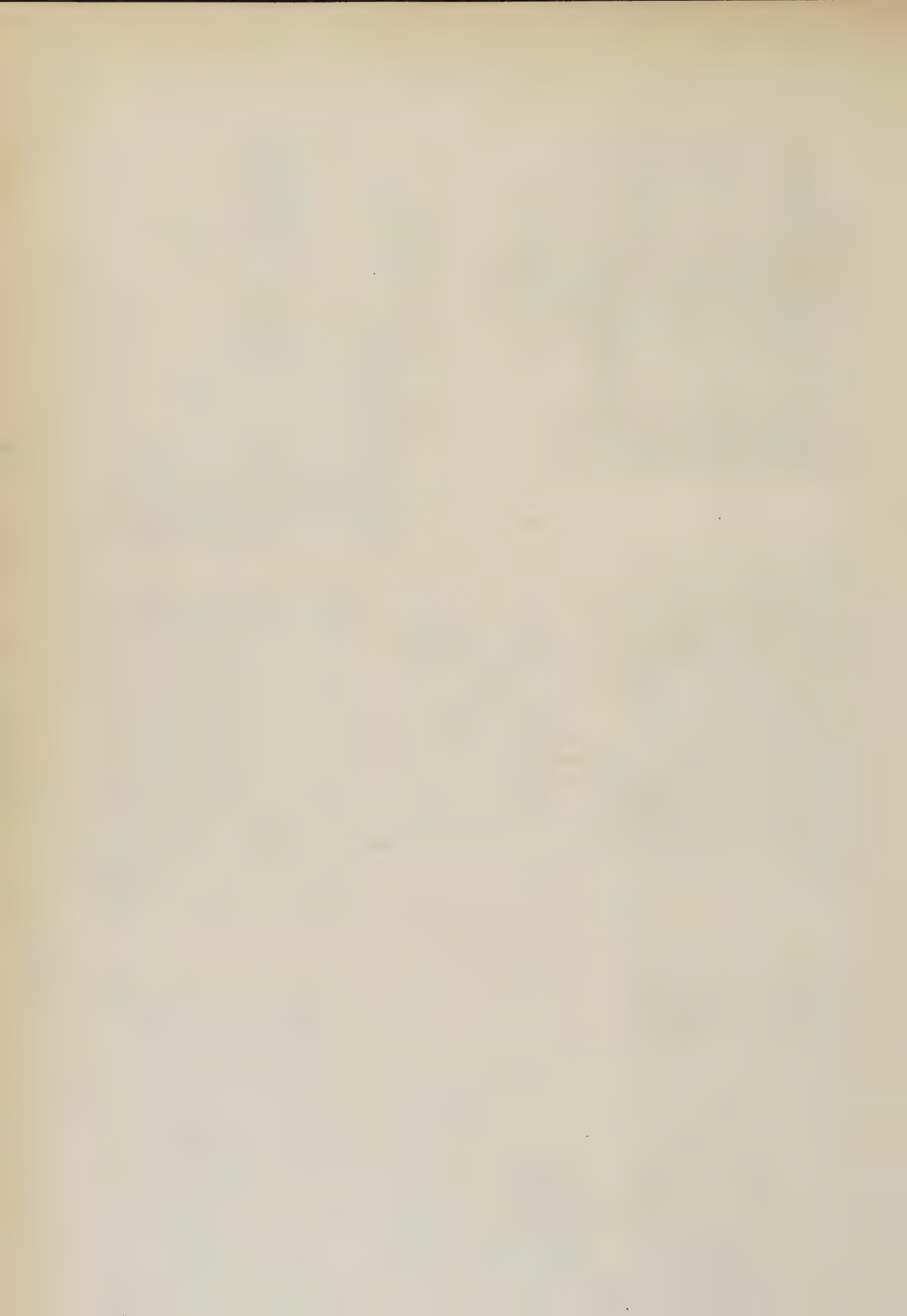
7



8



5



On the Periodical Flowering of the Bamboo⁽¹⁾

By **Seichi KAWAMURA**

With Plate XI and 6 Text-figures

(Received October 19, 1927)

1. Introduction

Some years ago the flowering of the bamboo was witnessed in our country. Though the cultivated thick-stemmed bamboos, such as the "Madake,"⁽²⁾ "Hachiku,"⁽³⁾ "Mosochiku,"⁽⁴⁾ "Hoteichiku,"⁽⁵⁾ "Kanzanchiku,"⁽⁶⁾ etc., usually do not bear flowers, still historical bibliography contains several records of their flowering. Bamboo-brakes composed of the same species come into flower simultaneously, or more accurately in the course of a few years, and afterwards wither down, without a single exception in the brake; while some of the subterranean stems remain alive and, sending forth new sprouts gradually restore the original features of the brake.

This phenomenon occurs universally and simultaneously in the case of all brakes of the same species even though situated in different provinces and different latitudes.

This universal and simultaneous character is one of the peculiarities of bamboo-flowering and reminds one of an epidemic of some infectious disease, which it seems closely to resemble. When one bamboo-brake comes into flower, it is the case without any exception that hundreds and thousands of other bamboo-brakes consisting of the same species will be sooner or later filled with the flowering bamboo.

(1) Paper read before the Pan-Pacific Science Congress held in Tokyo October—November 1926.

(2) *Phyllostachys bambusoides* S. et Z.

(3) *Phyllostachys nigra* MUNRO var. *Henonis* STAPF (= *Ph. puberula* MUNRO = *Ph. Henonis* MITF.)

(4) *Phyllostachys edulis* A. et C. RIVIÈRE.

(5) *Phyllostachys aurea* RIV. (= *Ph. bambusoides* S. et Z. var. *aurea* MAK.)

(6) *Arundinaria Hindsii* MUNRO.

Nagasaki, Fukuoka, Saga, Ehime, Kochi, Tokushima, Kagawa, Wakayama, Hiroshima, Okayama, Tottori, Shimane, Hyogo, Kyoto, Nara, Miye, Chiba, Kanagawa, Saitama, Yamanashi, Gifu, Niigata, Fukushima, Tochigi, Gumma and Nagano, which led to the conclusion that "Hoteichiku" bore flowers at the same time, regardless of difference of locality. The cold climate, by the way, of the northeastern prefectures is unfavourable to the growth of "Hoteichiku," which accounts for the fact of the absence from the above list of the names of those prefectures.

In 1918 Kumesaburo KAYABA attempted to introduce some bamboos ("Madake," "Mosochiku," "Hachiku,") into Hokkaido, where up to that time no bamboo of the genus *Phyllostachys* had been found.

The transplantation was successful only for "Hachiku," which species has spread over the southern parts of Hokkaido and is now found flourishing in several places. These transplanted "Hachiku" in the colder part of our country likewise flowered in 1908-1910.

Experiments oppose the Malnutrition Theory

A series of experiments was carried out by experts at the Kyoto Agricultural Experimental Station, to cure, if possible, by ample manuring the "Flowering Disease" of "Hachiku" and its allied species, "Kurochiku" (*Phyllostachys nigra*, MUNRO) which also flowered simultaneously with the former. This was continued as long as seven years, beginning in December 1903 and led to the result that no effect of ample manuring could be observed on the relative number of the issuing culms; while the few surviving aerals, when manured, showed, as the single effect observed, a thicker and longer growth in restitution period,

Summary.—"Hachiku" and its allied species, "Madake," as well as "Kanzanchiku," "Hoteichiku" came into flower universally independent of (1) the age and extension of the brake; (2) the thickness of the aerial stem; (3) the fertility or humidity of the soil; (4) exposure to the sun; and (5) the climate of the locality; also (6) the phenomenon continued for a few years, the period being different for each species.

3. Flowering takes place periodically

The author had been told by many aged persons that they had witnessed "Madake" flowering in their younger days, about 1846.

One of them asserted that he had observed "Hachiku" brakes bearing flowers or withering down in 1860, in Kyoto, Osaka and their vicinities.

In the bibliography the author found the following historical records of bamboo-flowering.

UEHARA⁽¹⁾ describes an universal flowering of "Hachiku" about 1786, and of "Madake" in some years in the Kyoho era (1716-1735).

ENDO⁽²⁾ records that universal flowering and withering of "Hachiku" occurred in 1666, all over the country; while bamboos of other species remained intact.

OYAMADA⁽³⁾ describes the universal flowering and consequent withering of "Hachiku" in our country as taking place in the middle of the thirteenth century, about 1247.

The "Fuso-Ryakki," records the universal flowering and withering of "Hachiku" in 931.

In the "Nihon-Kiryaku," a similar phenomenon in 813 is described.

year	interval
813	118 = 2×59
—	
931	
—	316 = 5×63.2
—	
—	
—	
1247	
—	419 = 7×59.86
—	
—	
—	
—	
—	
1666	120 = 2×60
—	
1786	62
1848	60
1908	

(1) Mukyu UEHARA: "Gokoku-Muzinzo" (1787).

(2) Genri ENDO: "Honzo-Bengi" Vol. 4 (1681).

(3) Kosei OYAMADA: Matsunoya-Hikki, Vol. 40.

If we take the intervals between the above mentioned times of flowering of "Hachiku" it is obvious, that the interval appears to be an integral multiple of 60.

Taking into account the lack of complete chronological records such as the above, we may be justified in concluding that the flowering of "Hachiku" has occurred at intervals of about 120 (occasionally 60) years.

As for "Madake," although less perfect records were obtained, the author could recognise that the flowering occurred in the Kokwa era (1844-1847) simultaneously all over the country, apparently reaching its maximum in the year 1846, as stated by OTA⁽¹⁾ and in some other manuscripts, as well as confirmed by several personal recollections. The same phenomenon observed in some years of the Kyoho era (1716-1735) was described in UEHARA's Gokoku-Jujinzo (1787). If we take the middle year (1726) of the Kyoho era, and compare it with the middle year (1846) of the Kokwa era, 120 years may be recognised as the interval between the two flowering periods of the species "Madake." Therefore we may say that "Hachiku" appears very probably to flower every 120 years, while "Madake" also flowers every 120 years, the flowering period of the latter succeeding that of the former with an interval of 60 years.

As for "Kanzanchiku" and "Hoteichiku," the historical record of their flowering has not yet been discovered, and the interval between periods can not be determined.

As the flower of "Hoteichiku" was apparently never before observed, its form remained unknown till the last flowering period. Now that the form of the "Hoteichiku" flower is exactly known and described, the author urges that the pictures shown in the *Icones of Bamboos in Japan*,⁽²⁾ should be corrected. What is there represented as the flower of "Hoteichiku" is really that of a "Hachiku." There are reasons for suspecting that the mistake occurred because that "Hoteichiku" was cultivated side by side with the "Hachiku" in the specimen garden of the Forestry Experimental Station at Meguro, near Tokyo, and the flower of an isolated issue of the "Hachiku" species was plucked and sketched, and then erroneously identified as the flower of "Hoteichiku."

(1) Shitoku OTA: "Kwanno-Hyakushu" (1850).

(2) *Icones of the Bamboos of Japan*, Pl. 3, Bureau Forest., Dept. Agr. Comm. (1912).

Knowing that the "Madake" and "Hachiku" were introduced into our country from the continent in ancient times, the author searched after chronological records in old Chinese bibliography and found in the "Gogyôshi," a description of bamboo flowering in 1114, and also in the "Kôgumpôfu," (Vol. 84, "Bamboo,") a record of flowering in 999. The interval calculated being 115 years coincides fairly well with the theoretical round number 120. It is worth mentioning that some ancient Chinese writers refer to the periodical flowering of the bamboo at intervals of sixty years.

4. Conclusion

By the above mentioned facts, the author might naturally feel qualified to attribute the flowering of the bamboo not to such extraneous conditions as deficient fertility of soil, solar illumination, temperature, or some other climatological factors, but rather to some inherent property of the bamboos themselves peculiar to each species, resulting in the universal flowering at regular intervals.

In order to explain the direct cause of the periodicity, some may suggest the volcanic activity of our country, which seems to occur at certain intervals, the length of which is, however, impossible to determine exactly; other may assume that the periodical fluctuations of climate (BRÜCKNER'sche Klimaschwankungen) are the effective agency.

All these possible explanations seem to lose most of their validity in face of the fact that different species come into flower at different times, each proper to its species. The same objections hold good as to SUESSENGUTH's views partly attributing the bamboo flowering to the effect of sun-spots.

If we consider the fact that the reproduction of the bamboo is carried out, as a rule, in an asexual way by means of subterraneans, all the bamboos in the widespreading brakes if they originated at first from the same subterranean, may be said from the ontogenical point of view to be parts of one and the same individual having the same age. It thus happens that all the bamboos of one species in different parts of the land bear flowers at the same time. Another example of a plant flowering at long intervals is the Century-plant (*Agave americana*, L.), which likewise flowers universally. Thus the author found in the summer of 1923 in a green house in the Kew Royal

Botanical Gardens, England, a dead tall rachis of this plant and was reminded of its universal flowering in Japan which had occurred some years previously.

A similar phenomenon is observed in the case of the American periodical cicadas, the young forms being said to spend either thirteen or seventeen years underground before emerging as adults, according to which fact they are said to belong to the thirteen-year or the seventeen-year species. Therefore, I am compelled to believe that the periodical cicadas and some bamboos are remarkable representatives of living things which have special characteristics of periodical as well as simultaneous reproduction, and that their emergence has no relation to climate, soil or any other external conditions.

APPENDIX

On the Flower of "Hoteichiku" ⁽¹⁾

The flower of "Hoteichiku" has never been observed by us before its gregarious flowering in 1916-21. Though the figures of its flower are found in some scientific publications,⁽²⁾⁽³⁾ the evidence of its identity appears to be yet lacking.

"Hoteichiku" was sometimes taken for a variety of "Madake" on account of the similarity of certain features of their respective culms. According to the description and the figures already published,⁽²⁾⁽³⁾ however, the flower of "Hoteichiku" is similar to that of "Hachiku" (Figs. 2, 3 and 6) rather than to that of "Madake." It might seem therefore to be preferable to consider "Hoteichiku" as a variety of "Hachiku" because in the systematic classification we must lay naturally more weight on the flower form than on the culm character, just as we rank "Hachiku" and "Ummonchiku" ⁽⁴⁾ among the varieties of "Kurochiku."

Since I had recently a good opportunity of observing and sketching the flowers of "Hoteichiku" in their most active period I think it worth while to indicate below their flower form, etc., as observed by myself (s. Figs. 4, 5 and Pl. XI).

If we compare the inflorescence of "Hoteichiku" with that of "Hachiku" and some other allied species, as "Madake," "Mosochiku" (s. Fig. 6), we will recognise its certain resemblance to that of "Madake" concerning the shape of its spikelet, while quite notable differences are observed when we compare it to that of "Mosochiku" and especially to that of "Hachiku." If we consider the outer glume its microphyll is largest in "Hoteichiku," then comes that of "Madake," whilst in the two other species it is far smaller, that of "Hachiku" being smallest (Fig. 6). If we take the shape of the

(1) This part is a new addition to the paper read before the Pan-Pacific Science Congress.

(2) Icones of the Japanese Bamboos, publ. by Bureau Forest., Dep. Agric. and Comm., 1912, Pl. 3.

(3) TSUBOI, I.: Atlas of Bamboos. According to a private communication of this author the figure of "Hoteichiku" flowers in his Atlas is the one which was provisionally copied from the "Icones of Japanese Bamboos" cited in the preceding foot-note.

(4) *Phyllostachys nigra*, MUNRO var. *Henonis* STAFF forma *Bolyana*, MAK.



Fig. 2. A branch of "Hachiku" in full flower development
($\frac{1}{2}$ nat. size).

spikelets into consideration it is at once evident that "Hoteichiku" on one side and "Hachiku" or "Mosochiku" on the other must belong to different species. It may further be remarked that "Hoteichiku" and "Hachiku" ought to be looked upon as different species, not only on account of their dissimilar spikelet shape, but also on that of the different period of their flowering, which is known to occur simultaneously in all varieties of "Hachiku," such as "Kurochiku," "Ummonchiku," etc. The name *Phyllostachys bambusoides*, SIEB. et ZUCC. var *aurea*, MAK. or *Ph. reticulata*, MAK. var *aurea*, MAK. now generally used for "Hoteichiku" must therefore be replaced by *Phyllostachys aurea*, Riv., that which was prevalent in early times and became now almost obsolete. It is also obvious on account of the flower form that the name, *Bambusa aurea*, hort. is not at all applicable to this species.



Fig. 3. A clump of "Hachiku" (*Phyllostachys nigra* MUNRO var. *Henonis* STAFF) in full flower development in the Tokyo Botanical Gardens (1911).



Fig. 4. A small clump of "Hoteichiku" (*Phyllostachys aurea*) in pot in its full flower development in Tokyo (May 1919). The transplanted culms flowered soon after the parent stock.



Fig. 5. A branch of "Hoteichiku" in full flower development. Few leaves remaining on a nearly dead branch (nat. size).



Fig. 6. Spikelets and glumes of some *Phyllostachys* species (nat. size).

1. "Hachiku" (*Ph. nigra* MUNRO var. *Henonis* STAPF)
2. "Madake" (*Ph. bambusoides*, SIEB. et ZUCC.)
3. "Hoteichiku" (*Ph. aurea*, RIV.)
4. "Mosochiku" (*Ph. mitis*, RIV.)

Explanation of Plate XI

All figures in the plate refer to the flower of "Hoteichiku" (*Phyllostachys aurea*, Riv.)

Fig. 1. A branch bearing flowers in full development (nat. size).

Figs. 2, 3, 4. Spikelets.

Fig. 5. Stamen.

Fig. 6. Inner palea.

Fig. 7. Outer palea.

Figs. 8, 9. Inner glume.

Fig. 10. Inner glume.

Fig. 11. Outer glume (dry).

Fig. 12. Fruit (seldom obtainable).

Fig. 13. Pistil.

Fig. 14. Floral diagram: *r*, rachis; *10*, outer glume; *8*, *9*, inner glume; *7*, outer palea; *6*, inner palea; *1*, lodicules; *s*, stamen; *p*, pistil.



PLATE XI



S.Kawamura del.1919.

Abstracts No. 1—88

(Referring to the principal papers on Botany and allied subjects which have appeared in Japan mostly during January—December 1925)

1. Contribution to the Physiology of Lichens (Japanese). Ryôsi AMO. (Bot. Mag. Tôkyô **39**, 1925, (361)–(380), with figs.).

A. Influence of SO₂-Gas.—Lichens are injured by SO₂-gas, either in gaseous state or dissolved in rain-water. In the first case the injury is most prominent, when they contain much water and also when they are under direct sunlight. In the second case the injury is due to the high ion-concentration of the rain water. Since the Lichens are much more sensible to the action of SO₂ than higher plants, we can easily understand why they gradually disappear in smoky places.

B. Resistance against Dessication.—*Parmelia praetervisa* is xerophytic and able to live so long as three months within a dessicator containing only 2-3 % water of their dry weight. *Sticta pulmonaria*, *S. Miyoshiana*, *S. adscripta*, *Cladonia rangiferina*, *Parmelia praetervisa* and *Usnea longissima* are able to absorb a great deal of water in damp atmosphere, but will lose it very rapidly as soon as the atmosphere will become dry. All these facts explain why the Lichens are able to maintain their physiological activity even in the atmosphere where the humidity is very changeable.

C. Geotropism.—If a podetium of *Cladonia gracilis* var. *leucochloa* is placed out of its original upright position, it curves upwards within a time, which may be said to be very short in view of its extremely slow growth.

2. Nillsonia-Bed of Hokkaidô and its Flora. Seidô ENDÔ. (Sc. Rpts. Tôhoku Imp. Univ. Ser. II (Geology) **7**, 1925, 57-72, 7 pls.). [S. Japan Jour. Geol. Geogr. **3**, 1924, (24), Abstract No. 43.]

3. Über den Zusammenhang zwischen der Pufferwirkung der Kulturlösung und der Oxalsäurebildung von *Aspergillus niger*. (Japanisch). Kazuo GOTOH. [Bot. Mag. Tôkyô **39**, 1925, (264)–(283)].

Um den Chemismus in der Pilzkultur genau zu studieren, sind die gewöhnliche Kulturmethode, die einmalige Nachweisung der produzierten Stoffe in der Kulturlösung am Ende des Versuchs usw. unter Umständen ungenügend, weil die chemische Funktion des Pilzes durch die fortwährende Veränderung der Kulturbedingungen immer verschieden beeinflusst wird.

In den vorliegenden Untersuchungen über die Oxalsäurebildung von *Aspergillus niger* wurde besondere Rücksicht hierauf genommen und die Versuche ausgeführt, indem im Verlaufe der Kultur die alte Kulturlösung mit derjenigen von anderer oder derselben Zusammensetzung gewechselt wurde.

In der vorliegenden Arbeit versteht Verf. unter Pufferwirkung, der Bequemlichkeit halber, jene Wirkung der Lösung, welche nur die Vermehrung der H-Ionenkonzentration hemmen, entweder im strengen Sinne der Pufferung oder durch Neutralisation, ja selbst durch die aus dem Stoffwechsel resultierende Verminderungstendenz der H-Ionenkonzentration. Als solche Puffer dienen NaNO₃ (als N-Quelle), Na₂HPO₄ u. a.

Zusammenfassend konnte der Verf. aus einer Reihe von Versuchen die folgenden Resultate bekommen:

Aspergillus niger besitzt die Fähigkeit der Oxalsäurebildung selbst über der optimalen Acidität für das Wachstum, wenn der Kulturlösung die betreffende Pufferwirkung zukommt: z. B. in der Kultur, wo NaNO_3 als N-Quelle verwendet und deren initiale Acidität durch Zusatz von HNO_3 sehr erhöht wird. Die Oxalsäurebildung findet stärker statt, je grösser das Puffervermögen der Kulturlösung ist. Diese ist deshalb viel mehr von der Pufferwirkung abhängig als die H-Ionenkonzentration selbst und man kann sagen, dass es keine Grenzkonzentration der H-Ionen für Oxalsäurebildung von *Aspergillus niger* gibt.

Da die Erniedrigung der aktuellen Acidität, die beim Wechseln der Kulturlösung zukommt, oder die salzfreie Kultur (vgl. ELVING 1918-1919) auch als Pufferung im weiteren Sinne wirkt, findet man dabei eine merkliche Oxalsäurebildung.

Das einmal hervorgerufene Vermögen der Oxalsäurebildung des Pilzmycels wird nach dem Wechseln der Kulturlösung beibehalten. Diese Fähigkeit wird durch die stärkere Pufferwirkung der zweiten Kultur weiter verstärkt und durch die schwächere vermindert. Obwohl sie durch das Wechseln der Kulturlösung oft unwirksam gemacht wird, so scheint sie dabei im latenten Zustande eine Zeitlang beibehalten zu werden. Ob die hervorgerufene Veränderung der Eigenschaften der Oxalsäurebildung weiter durch die Konidien zu den folgenden Kulturen übertragen werden kann, muss noch dahingestellt bleiben.

Verf. hat auch die Sklerotienbildung von *Aspergillus niger* auf Agar-Boden beiläufig untersucht und festgestellt, dass diese auch von der Pufferwirkung des Nährbodens abhängig ist und zwar durch dieselbe der folgenden Kulturen immer verstärkt wird.

Autor.

4. Genetic Studies of Leaf-Character in the Morning-Glories. II-III. (Japanese). Tokio HAGIWARA. (Bot. Mag. Tôkyô **39**, 1925, (77)-(97), 10 figs.; ditto, (187)-(197), 1 fig.).

In respect to the leaf-shape there are commonly four different kinds, which are known by the Japanese names *Namiba*, *Tonboba*, *Rangikubi* and *Tatutaba* respectively. They as well as their combinations may be genetically represented by several different combinations of the four allelomorphic pairs *K, k*, *H, h*, *I, i*, *M, m*. *Nantenba* and *Kujakuba* are two other kinds of leaf-shape; the author has described the genetic behaviour of their respective genes *n_a* and *p*. Another leaf-shape "Takaraminoba" is due to the presence of four recessive genes *p*, *m*, *n* and *s_a*, the latter alone causing still another leaf-shape known under the name *Sasa*.

5. Variations and Correlations in the Welsh Onion. (Japanese). Sukeaki HAKAMADA. (Japan. Jour. Genetics **3**, 1925, 83-100, 2 figs.).

A number of seed clusters of the variety of *Allium fistulosum* known under the name *Senzgunegi Kurogara* grown under natural pollination were drawn from several growers. Each seed cluster was sown separately, from which the author has got in all 101 lines, plants from each cluster being considered to belong to one line. Variation and correlation of several characters were studied. The variability of characters is naturally different in different cases, that of the tillering being for example greatest. The correlation coefficient between two characters has been calculated in many cases, and the author gives a table representing various correlation coefficients at the setting and the harvesting season, the coefficients between any two characters being found to be different in these two different seasons.

6. Untersuchungen über das Acaciin, ein neues Flavonglykoside aus den
 Entries 4-6

Blättern von Robinia pseudoacacia, L. Sizuo HATTORI. (Acta Phytochem. **2**, 1925, 99-112, 1 Taf.).

7. Alsophila Ogurae, a New Species of Tree-fern from the Bonin Islands, together with Notes on the Cyatheaceae found in the Same Group. Bunzô HAYATA. (Bot. Mag. Tôkyô **39**, 1925, 147-151).

A new species of tree-fern from the Bonin Islands, *Alsophila Ogurae* is described.

8. On Moliniopsis, a New Genus of the Gramineae of Japan. Bunzô HAYATA. (Bot. Mag. Tôkyô **39**, 1925, 255-258, 10 figs.).

A new genus of the Gramineae with its single species *Moliniopsis japonica* from Hokkaidô is described. It was formerly known under the name *Molinia japonica* HACKEL.

9. On a Cercosporcellose of the Cultivated Lily. (Japanese). Makoto HIURA. (Ann. Phytopathol. Soc. **1**, 6, 1925, 20-30, 1 fig.).

In 1922 an epidemic cercosporcellose of the cultivated lily (*Lilium Maximowiczii*) occurred in some districts of Hokkaidô. The disease is chiefly confined to the foliage. Though the morphological characters of the causal fungus coincide pretty well with those of *Cercospora inconspicua* (WINT.) von HÖHNEL the author thinks that further investigations are necessary for its definite identification. The symptoms of the disease may be divided into three distinct stages. At first the affected areas take a powdery mildew-like appearance; in the second stage the lesions are characterized by their brownish colour, and in the third and final by their blackened burned out appearance. The causal fungus hibernates in dead tissues of diseased leaves. Author.

10. On Chaetoceras Eibenii Grun. (Japanese). Jiro IKARI. (Bot. Mag. Tôkyô **33**, 1925, (52)-(59), with figs.).

Chaetoceras Eibenii has been observed for the first time in Japan. The author has studied the formation of auxospore and microspore.

11. Genetic Studies in Morning Glories XV. (Japanese). Yoshitaka IMAI. [Bot. Mag. Tôkyô **39**, 1925, (43)-(52).]

A pure race bearing cream flowers which behave recessive towards the colored ones, is ever sporting, and gives off regularly some plants with colored flowers, the percentage of the latter being about 6 %. The sports thus produced are always heterozygous, the segregating ratio of coloreds and creams being respectively more or less 3>1.

12. On the Taxonomy of Shii-take and Matsu-take. Seiya ITO and Sanshi IMAI. (Bot. Mag. Tôkyô **39**, 1925, 319-328, 1 pl.).

Shiitake and Matsutake are the commonest edible mushrooms of Japan. The former was placed among the genus *Agaricus*, *Collybia*, *Armillaria*, *Lepiota*, *Cortinellus* and *Shitake* by different authors, and was given various specific names. The authors propose for it a new name, *Cortinellus Berkeleyanus*. As also for Matsutake there were various scientific names they propose for it a new name, *Armillaria Matsutake*.

13. A Preliminary Report of Crossing Experiments with Cruciferous Plants, with Especial Reference to Sexual Compatibility and Matroclinous Hybrids. Yôiti KAKIZAKI. (Japan. Jour. Genetics **3**, 1925, 49-82, 8 figs.).

(4)

The author has made pollination experiments on the three varieties of *Brassica campestris*, *B. japonica*, the two varieties of *B. oleracea*, *B. nigra*, *B. juncea* and *Raphanus sativus*. All self-pollinated flowers exhibit less fertility than those left to natural pollination, the grades of self-incompatibility being exceedingly variable in different cases.

The cross-pollination between 1. different plants of the same variety, 2. different varieties of the same species, 3. different species of the same genus, and 4. different genera (*Brassica* and *Raphanus*) were performed. The results are 1. complete or nearly complete fertility, 2. complete fertility, 3. and 4. variable, sometimes entire incompatibility. Hybrids produced by cross-pollination are either of the normal or matroclinous type. The latter case of inheritance may be due to pseudogamy; the non-occurrence of parthenogenesis has been experimentally proven.

14. Weitere Untersuchungen über die pentaploiden Triticum-Bastarde. I. Hitoshi KIHARA. (Japan. Jour. Bot. **2**, 1925, 299-304, 1 Taf.).

15. Chromosomes of Rumex acetosella, L. (Japanese). H. KIHARA. (Bot. Mag. Tôkyô, **39**, 1925, (353)-(360), 21 figs.).

The author has found two male plants differing in the number of chromosomes. The chromosomal formulae of the two plants are as follows:

	Formula	Place of collection
(A)	$42=21^b+0^i$	Berlin-Dahlem
(B)	$41=20^b+1^i$	Berlin-Dahlem

In both plants the ring formation of chromosomes is observed. The ring consists of 2 or 3 large pairs, which are called **aa**, **bb** and **cc**. The ring with four units (not three units as in MEURMAN'S case) is most frequently seen, and this ring has **aa** and **bb** as its components. Sometimes there is no ring. Often we see another ring with four smaller units.

The behavior of the tetrapartite and hexapartite ring chromosomes is described.

In the heterotypic anaphase of the plant (A), we can clearly count 21 daughter chromosomes in both plates, and three large chromosomes, **a**, **b** and **c** can easily be distinguished from others in each plate.

The univalent chromosome of the plant (B) goes to the pole slightly earlier than other chromosomes, so that the two daughter plates have 21 and 20 chromosomes respectively.

The author is not quite sure, whether these two plants may be considered as two different varieties or not.

Author.

16. Investigations on the Nelson's Bodies as Observed in the Leaf-roll, Mosaic, and Healthy Plants. Mikio KASAI. (Ber. Ôhara Inst. landw. Forsch. **2**, 1924, 443-461, 4 pls.).

In 1922 RAY NELSON has published the remarkable fact that there are found in potatoes affected with leaf-roll and in the phloem cells of various plants suffering from mosaic certain kinds of protozoan organisms-NELSON'S bodies. Later investigations of various authors could not confirm the NELSON'S statement. A new investigation of the author on petioles and stems of several kinds of plants has revealed the fact that in the phloem parts there are found bodies markedly resembling the NELSON'S protozoa, which are present both in diseased and healthy plants. The author thinks that these bodies are nothing but either disintegrated or even normal nuclei which are very often found in the elongated cells and have therefore nothing to do with the "virus" diseases.

17. *Fusarium Solani* (Mart. pr. p.) App. et Wr. as the Causal Agency of Dry-rot in the "Konnyaku"-Corms. Mikio KASAI. (Ber. Ôhara Inst. landw. Forsch. **2**, 1924, 463-471, 1 pl.).

The investigation refers to the cause of dry-rot disease in *Amorphophallus Konjac* KOCH, caused by *Fusarium Solani* (MART. pr. p.) ART. et WR. The fungus infects mostly the corms. The infected portion appears at first sunken and wrinkled, which becomes deeper and deeper, till finally the flesh is totally destroyed and the corms mummify. The author has made the culture on various media, and describes the behavior of the fungus in them.

The causal fungus is considered to be *F. Solani*; it differs from *F. coeruleum* (LIB.) SACC. in the following respects, 1. the non-production of the indigo-blue color, 2. the form of macroconidia, and 3. the behavior of aerial mycelium in the culture.

18. *Fusarium Aspidioti* Sawada, its Culture and Morphology. Mikio KASAI. (Ber. Ôhara Inst. landw. Forsch. **2**, 1925, 547-558, 1 pl.).

Fusarium Aspidioti SAWADA is known by its parasitic action upon the San Jose scale insect (*Aspidiotis perniciosus* COMST.). The author has done its culture on various media, and describes its morphology concerning mycelium, conidiophore, micro- and macroconidia, as well as *Cephalosporium* stage. PERCH thinks this species to correspond to *Fusarium epicoccum* McALPINE. The author does not incline to the latter view, and thinks that it should retain the name *F. Aspidioti*.

19. Contributiones ad Salicologiam Japonicam I. Arika KIMURA. [Bot. Mag. Tôkyô **40**, 1926, 7-14].

Es werden 5 neue japanische Arten der Gattung *Salix* aufgestellt: *S. eriocataphylla* (♀), *S. gracilistyloloides* (♀), *S. Hiraoana* (♀), *S. leucopithecia* (♂) und *V. sumiyosensis* (♀).

Autoreferat.

20. Experiments on the Influence of Thorium Salts upon the Growth of Plants. (Japanese). Zirô KIMURA. (Jour. Sc. Agric. Soc. Japan No. **272**, 1925, 132-136).

The culture experiments of barley and water rice with addition of various quantities of thorium salts were done. It was found that in barley the addition of 0.01 mg. of thorium nitrate per 1 kg. soil leads to a certain increase of harvest, while in rice it has no effect whatever.

21. Biochemische Studien über Phycoerythrin und Phycocyan. Zenjiro KITASATO. (Acta Phytochem. **2**, 1925, 75-97, 3 Tafeln).

22. On the Fungus luxuriantly grown on the Bark of the Trees injured by the great Fire of Tokyo on September 1, 1923. Kimizô KITAZIMA. (Ann. Phytopathol. Soc. Japan **1**, 6, 1925, 15-19).

The contents of this paper are nearly the same, as described in Japan. Jour. Bot. **2**, 1925, (12), Abstract No. 36.

23. Über den Einfluss der Aussenbedingungen auf das Blütenöffnen der Reispflanzen. (Japanisch). Yakiti KOBAYASI. (Jour. Sc. Agric. Soc. Japan No. **274**, 1925, 239-246, 1 Abbild.).

Der optimum Feuchtigkeitsgrad für das Blütenöffnen der Reispflanzen beträgt 70-80 %.

Die mit Feuchtigkeit ganz gesättigte Luft scheint diesen Vorgang etwas zu verhindern. Der Verf. hat ihn sowohl bei der natürlichen Aussenbedingung als bei der mit Feuchtigkeit gesättigten Luft untersucht: er fand, dass im letzteren Falle 1. die Antheren oftmals gar nicht platzen, 2. die Narben gar nicht oder mit sehr wenigen Pollenkörnern bedeckt sind, und 3. dementsprechend das Fruchtungsprozent der in solcher Umgebung entwickelten Rispen bloss 58,6 % statt der normalen 86,3 % beträgt.

24. Contributiones ad Cognitionem Florae Asiae Orientalis XXXVIII. Gen'iti KOIDZUMI. (Bot. Mag. Tôkyô 39, 1925, 1-30, 299-318).

Among almost 130 plants enumerated there are one new genus *Chilcusichloa* (Panicaceae), many new species, varieties and names.

25. On the Meiosis and the Chromosome Number in Different Races of *Solanum Melongena*, L. (Japanese). Hitoshi KOJIMA. (Bot. Mag. Tôkyô 39, 1925, (119)-(123), 1 pl).

The pollen-mother-cells of the two races, "Shinkuro" and "Hakata-mizunasu" for the study of the meiotic mitoses were used. The diploid number of chromosomes was determined in 21 different races, and the haploid number in 6 of them.

So far as the author's observation has shown, the behavior of the spireme in the reduction division of these plants seems rather to suggest a case of telosyndesis.

Though the difference of the morphological characters of these races is by no means inconspicuous, so that some authors classify them into several varieties, no perceptible difference in the form, size and number of chromosomes was found among them. The diploid number is 24 and the haploid number 12 in all the observed races.

These chromosome numbers, $x=12$, $2x=24$, found in the 21 races of *Solanum Melongena*, L., considered together with the known chromosome numbers, $x=12$, 18, 24, 36, 72, in other genera among the Solanaceae, indicate that there exists a multiple relation $n \times 6$ of chromosome numbers in this family, 6 being the basic x -number. Author.

26. Die physiologischen und zytologischen Veränderungen durch die harten und weichen Röntgenstrahlen auf *Vicia faba* und *Pisum sativum* (französische Rasse). (Japanisch). Hideo KOMURO. (Bot. Mag. Tôkyô 39, 1925, (233)-(258), 3 Abbild.).

Einige Schlüsse, welche der Verf. aus seinen Untersuchungen zieht, sind die folgenden:

1. Die Wirkung der unterbrochenen Bestrahlung ist stärker als dieselbe der kontinuierlichen, entweder in physiologischer oder zytologischer Hinsicht.

2. Der Wassergehalt der Samen zur Bestrahlungszeit spielt eine grosse Rolle bei der zytologischen Veränderung der Wurzelspitzen der aus den bestrahlten Samen hervorgegangenen Pflanzen.

3. Die Karyolyse, die den verschiedenen chromatolytischen Zuständen folgt, ist das erste Endresultat der Degeneration. Die Pyknose erinnert an eine starke Wirkung der gegebenen X-Strahlen.

4. Es besteht keine Korrelation zwischen dem Wassergehalt der Samen in dem Bestrahlungsmoment und der Beschleunigung der Keimung.

5. Die Keimung der getrockneten Samen der Erbse wird durch die harte Bestrahlung mit Wolframantikathode beschleunigt.

6. Französische RÖNTGENRÖHREN (COOLIDGE-Typen nach GAFFE-GALOT-PILOT C¹⁰) verursachen die Knoten in den Wurzelspitzen Gewebe, was der Verf. RÖNTGENgeschwulst nennen möchte.

7. Die erste auffällige zytologische Veränderung durch die harte Bestrahlung ist

der hyperchromatische Zustand der Kerne und dieselbe durch die weiche der hypochromatische.

8. Es gibt merkwürdige Unterschiede der zytologischen Degenerationsstufen zwischen den harten und weichen Strahlen.

27. Ueber die Dauer der Erhaltung der Keimkraft bei verschiedenen Samenarten in Japan. (Japanisch). Mantarô KONDÔ. [Jour. Sc. Agr. Soc. **265**, 1924, 736-749].

Die Zeitdauer während welcher die Keimkraft von pflanzlichen Samen mehr oder weniger erhalten bleibt, ist je nach den Samenarten und verschiedenen äusseren Bedingungen sehr verschieden. Es spielen dabei die Art der Samen, die Herkunft, Witterungsverhältnisse bei der Ernte, Aufbewahrungsart usw. eine bedeutende Rolle. Während in Europa, Amerika und Australien über diese sehr wichtige Frage bereits eine Anzahl von Untersuchungen gemacht worden sind, liegen solche in Japan bisher noch nicht vor. Diese Lücke hat der Verfasser durch eine Anzahl eingehender Versuche, die sich über mehrere Jahre erstreckten, auszufüllen versucht. Er hat seit dem Jahre 1914, 82 Proben der verschiedensten Samenarten gesammelt und in Säckchen im Laboratorium aufbewahrt. Diese Samen wurden in jedem Jahre auf ihre Keimfähigkeit untersucht und die Dauer der Erhaltung der Keimkraft festgestellt.

Nach den von ihm erhaltenen Resultaten ist die Dauer der Erhaltung der Keimkraft verschiedener Samen sehr kurz und jedenfalls bedeutend kürzer als von BURGERSTEIN, CARRUTHERS, SIFTON, DORPH-PETERSEN u. a. m. festgestellt worden ist. Diese Erscheinung ist darauf zurückzuführen, dass das Klima in Japan im Sommer sehr feucht und auch sehr heiss ist. Es wird also sehr notwendig sein über zweckmässige Aufbewahrungsarten für Samen unter den Bedingungen des japanischen Klimas Versuche anzustellen:— er möchte dabei besonders betonen, dass die Verhältnisse in Europa und Amerika nicht auf japanische Verhältnisse übertragen werden dürfen.

Bezüglich der Dauer der Erhaltung der Keimkraft hat er dem Vorschlag EWARTS folgend eine Einteilung in die folgenden drei Kategorien vorgenommen:

A. *Microbiotische Samen*:— Die Keimkraft bleibt nur auf 1 Jahr oder höchstens 2 Jahre erhalten, dabei ist die Keimfähigkeit im 2 Jahre eine sehr geringe. Hierher gehören nach seinen Versuchen:— *Oryza sativa* (enthülster Reis), *Setaria italica*, *Fagopyrum esculentum*, *Capsicum annuum*, *Perilla nankinensis*, *Aralia cordata*, *Digitalis purpurea*, *Euphorbia* (*Poinsettia*) *pulcherrima*, *Delphinium ornatum*, *Phlox*, *Matricaria Chamomilla*, *Mallotus japonicus*, *Quercus serrota*, *Paulownia tomentosa*, *Alnus japonica*, *Gardenia florida* u. a. m.

B. *Mesobiotische Samen*:— Die Keimkraft bleibt auf 2-3 Jahre erhalten. Hierher gehören nach seinen Versuchen:— *Oryza sativa* (unenthülster Reis), *Hordeum sativum*, *Triticum vulgare*, *Andropogon sorghum*, *Glycine hispida*, *Cucumis melo*, *Lagenaria vulgaris*, *Lycopersicum esculentum*, *Spinacia spinosa*, *Allium fistulosum*, *Asparagus officinalis*, *Daucus Carota*, *Arctium Lappa*, *Cannabis sativa*, *Gossypium herbaceum*, *Papaver Rhoeas*, *Chrysanthemum maximum*, *Bellis perennis*, *Coreopsis Drummondii*, *Coreopsis tinctoria*, *Centaurea Cyanus*, *Zinnia elegans*, *Helianthus annuus*, *Kosmos*, *Helychrysum bracteatum*, *Cacalia*, *Ageratum*, *Gomphrena globosa*, *Sisyrinchium Bermudianum*, *Ietunia violacea*, *Antirrhinum majus*, *Matthiola incana*, *Dianthus chinensis*, *Salvia*, *Si'ene pendula*, *Hibiscus mutabilis*, *Althaea rosea*, *Lycium chinense*, *Cupressus* u. a. m.

C. *Makrobiotische Samen*:— Die Keimkraft bleibt bei diesen auf 4-5 Jahre oder noch länger erhalten. Es gehören hierher nach seinen Versuchen:— *Vicia Faba*, *Phaseolus Mungo*, *Astragalus sinicus*, *Vigna sinensis*, *Pisum sativum*, *Luffa cylindrica*, *Cucurbita moschata*, *Citrullus vulgaris*, *Cucumis sativus*, *Solanum Melongena*, *Beta vulgaris*, *Sesamum indicum*,

(8)

Raphanus sativus, *Brassica campestris* var. *chinensis*, *Chrysanthemum coronarium*, *Impatiens Balsamina* u. a. m. Autor.

28. Über die in der Landwirtschaft Japans gebrauchten Samen. (Vierte Mitteilung). Mantarô KONDÔ. [Ber. d. Ôhara Inst. Landw. Forsch. **2**, 1924, 397-428, 104 fig.].

In dieser Abhandlung hat der Verfasser über die Samen bzw. Früchte folgender Pflanzen berichtet: 1. *Cannabis sativa*, 2. *Morus*-Arten, 3. *Perilla nankinensis*, 4. *Perilla ocimoides*, 5. *Sesamum indicum*. Er hat stets die äusseren Merkmale bestimmt, den anatomischen Bau beschrieben, die Keimpflanzen untersucht und schliesslich die Arten-, Varietäten- bzw. Sorteneigentümlichkeiten dargestellt. Vergl. Jap. Jour. Bot. **1**, 1923, (38). Autor.

29. Über die in der Landwirtschaft Japans gebrauchten Samen. (Fünfte Mitteilung). Mantarô KONDÔ. [Ber. d. Ôhara Inst. Landw. Forsch. **2**, 1925, 559-595, 20 Fig.].

Der Verfasser hat in dieser Mitteilung hauptsächlich über Malvaceensamen berichtet und zwar 1. *Gossypium*-Arten, 2. *Abelmoschus Manihot*, 3. *Abelmoschus esculentus*, 4. *Hibiscus cannabinus*, 5. *Hibiscus Sabdariffa* und 6. *Abutilon avicennae*. Der Untersuchungsgang ist ebenso wie bisher. Vergl. Jap. Jour. Bot. **1**, 1923, (38). Autor.

30. Über die Einwirkung des Kalks auf die Erhaltung der Keimkraft von Samereien. [Japanisch.] Mantarô KONDÔ. [Jour. Sci. Agr. Soc. **266-271** (1925), 1-11].

MAYER, FILTER u. A. haben bereits gezeigt, dass ein Vermischen der Samen mit gebranntem Kalk während der Aufbewahrungszeit, konservierend auf das Keimvermögen wirkt. Die Versuche genannter Autoren schienen dem Verfasser aber nicht ausreichend und er hat daher eine Anzahl eingehenderer Versuche, die sich im Ganzen auf 10 Jahre erstreckten, ausgeführt. Er hat seit dem Jahre 1915, 55 Proben verschiedener Samen gesammelt und die Einwirkung des Kalkes auf deren Keimkraft untersucht. Schliesslich hat er den praktischen Gebrauchswert des Kalkzusatzes für die Aufbewahrung festgestellt.

Die Aufbewahrungsversuche hat er 5 mal wiederholt. Zuerst hat er die Samen auf folgende drei verschiedene Arten im Laboratorium aufbewahrt.

1. Die Samen wurden in Säckchen aufbewahrt.

2. Die Samen wurden in luftdicht verschlossenen Glasflaschen aufbewahrt.

3. Die Samen wurden mit gebranntem Kalk vermischt und in luftdicht verschlossenen Flaschen aufbewahrt.

Diese Samen wurden sämtlich in jedem Jahre auf ihre Keimfähigkeit untersucht und die Erhaltung der Keimkraft festgestellt. Dabei hat er gefunden, dass die Erhaltung der Keimkraft bei der dritten Aufbewahrungsart bedeutend bessere war, als bei der ersten und zweiten.

In einem weiteren Versuche hat er die Samen in Säckchen getan und dann mit Kalk in luftdicht verschlossenen Glasflaschen aufbewahrt,—die Samen also nicht mit Kalk gemengt,—er fand, dass die Wirkung auf die Erhaltung der Keimkraft eine ausgezeichnete war.

Bei einem weiteren Versuche hat er die Samen mit gebranntem Kalk gemischt und in luftdicht schliessenden Glasflaschen auf etwa einen Meter Tiefe in den Boden vergraben. Die Wirkung auf die Erhaltung der Keimkraft war bei diesem Versuch die beste.

Um nun den praktischen Gebrauchswert dieser Aufbewahrung mit Kalk festzustellen, hat

er 28 verschiedene Getreide-, Hülsenfrüchte-, Gemüse-, Blumen- und Forstsaamen einzeln in Säckchen verpackt und diese mit gebranntem Kalk in beinahe hermetisch schliessende Blechkästen eingelegt. Dann hat er die Blechkästen in einen hohen irdenen Krug gestellt, den er im Schatten in trockenem Boden ca. einen Meter tief eingegraben hatte. Diese einfache Methode erwies sich als zur Erhaltung der Keimkraft der Samen vollkommen hinreichend.

Fasst man die Ergebnisse obiger Versuche kurz zusammen, so lässt sich wohl behaupten, dass die Keimkraft sehr gut erhalten wird, wenn man die gut getrockneten Samen mit gebranntem Kalk in hermetisch schliessenden Blechkästen an einem kühlen, keinen allzugrossen Temperaturschwankungen ausgesetzten Orte aufbewahrt. Autor.

31. Über die Erhaltung der Keimkraft von Sämereien und Trocknungsmittel. (Japanisch). Mantarô KONDÔ. [Jour. Sci. Agr. Soc. 274, 1925, 221-231].

Der Verfasser hat schon darauf hingewiesen, dass der gebrannte Kalk auf die Erhaltung der Keimkraft von Sämereien sehr vorteilhaftig einwirkt. Ausserdem können vielleicht auch die Holzasche, Strohasche, Schwefelsäure sowie das Chlorkalzium dem gleichen Zwecke dienen. In diesem Versuche hat der Verfasser festgestellt, welche Mittel sich für die Erhaltung der Keimkraft am praktischsten eignen. Für diesen Zweck hat er erstens Vergleichungsversuche mit gebranntem Kalke, mit Holzasche und Reisstrohasche, zweitens Vergleichungsversuche mit konzentrierter Schwefelsäure, mit Chlorkalzium und gebranntem Kalke durchgeführt. Diese Versuche dauerten von 1916 bis 1925. Die in den Versuchen gebrauchten Materialien waren enthülste Reiskörner, Weizen, *Arctium Lappa*, *Daucus carota*, *Allium fistulosum*, *Brassica chinensis*, *Chrysanthemum coronarium* und *Sesamum indicum*. Die Ergebnisse sind sehr einfach. Sie sind wie folgt:—

1. Aus dem Vergleichungsversuche mit Kalk, Holz- und Strohasche im geschlossenen Raume, ersieht man, dass diese drei Mittel auf die Keimkraftverhältnisse gut einwirken, darunter aber wirkt gebrannter Kalk am besten, dann folgt die Holzasche, und zuletzt die Strohasche. Bei der Anwendung der Holz- und Strohasche muss man aber grosse Mengen gebrauchen, was ziemlich unpraktisch ist.

2. Wenn man die Sämereien, welche in den Exsikkatoren der konzentrierten Schwefelsäure, und des Chlorkalziums aufbewahrt wurden, mit den Sämereien, welche mit gebranntem Kalke gemischt und in geschlossenen Flaschen aufbewahrt werden vergleicht, so ersieht man, dass die Keimkraftverhältnisse fast gleich sind. Alle drei Mittel eignen sich für die Erhaltung der Sämereien vorzüglich.

3. In der Praxis muss man das Mittel auswählen, welches nicht zu kostspielig und gut zu handhaben ist. Verwendung der konzentrierten Schwefelsäure ist unpraktisch. Nach des Verfassers Ansicht ist die Verwendung des gebrannten Kalkes sehr empfehlenswert.

4. Die Ursache des Keimkraftverlustes der Sämerein beruht auf der Gerinnung des Protoplasmas und dem Enzyme- und Stoffverlust. Je trockener und kühler die Sämereien, um so schwächer sind diese Wirkungen und der damit verbundene Keimkraftverlust. Das Prinzip der Erhaltung der Keimkraft beruht also bekanntlich auf der trockenen und kühlen Aufbewahrung der Sämereien. Autor.

32. Untersuchungen der weissgestreiften Reispflanze (Shimaine). (Japanisch). Mantarô KONDÔ, Motoharu TAKETA und Sumita FUJIMOTO. [Jour. Sci. Agr. Soc. 277, 1925, 443-462].

Unter den gewöhnlichen grünen Reispflanzen findet sich zufällig oft eine weisslich-längsgestreifte Pflanze. Bisher bestehen eine Menge Veröffentlichungen von Untersuchungen
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chungen über die Buntblättrigkeit verschiedener Pflanzen, doch ist die weissgestreifte Reispflanze (Shimaine) noch keiner genauen Untersuchung unterworfen worden.

Seit dem Jahre 1916 haben die Verfasser Untersuchungen über die gestreifte Reispflanze angestellt und zwar über 1. ihre Morphologie und Anatomie, 2. die Gelegenheit ihrer Entstehung, 3. ihre Nachkommenschaft, 4. die Farbe der Reiskörner, 5. den Zusammenhang zwischen den verschieden gefärbten Reiskörnern und die Beschaffenheit der Nachkömmlinge, 6. den Zusammenhang zwischen der Verteilung der verschieden gefärbten Reiskörner in einer Rispe und der Beschaffenheit der Nachzucht, und schliesslich 7. die Bastardierung.

Die Ergebnisse sind die folgenden:

1. Die untersuchte gestreifte Reispflanze tritt als Mutante bezw. Pseudomutante der gewöhnlichen grünen Reispflanze auf.

2. Bei den weissgestreiften Pflanzen ist der Halm kürzer, die Bestockungsfähigkeit schwächer, die Kornzahl geringer, die Anzahl der unbefruchteten Körner aber grösser und das Korngewicht niedriger als bei den gewöhnlichen grünen Pflanzen.

3. Die Nachkommenschaft der gestreiften Reispflanzen bestand immer aus rein weissen, grünen und gestreiften Pflanzen. Die weissen Pflanzen gingen schon als Keimlinge ein; die Nachkommenschaft der grünen Pflanzen war immer grün; die Nachkommenschaft der gestreiften Pflanzen besteht immer aus weissen, gestreiften und grünen Pflanzen. Es ist also unmöglich, die konstanten weissgestreiften Pflanzen zu bekommen.

4. Das zahlenmässige Verhältnis der Nachkömmlingen der untersuchten gestreiften Pflanzen war das folgende: weisse Keimlinge (Albino) ca. 64 %, gestreifte Pflanze ca. 31 %, grüne Pflanze ca. 5 %. Es traten also bedeutend mehr Albino als gestreifte bezw. grünen Pflanzen auf.

5. Sehr oft aber kommt es vor, dass die Nachkommenschaft der gestreiften Pflanzen nicht gespalten ist, sondern konstant grün ist.

6. Es besteht eine Korrelation zwischen den Farben (weiss, gestreift, grün) der Reiskörner und der Farbe der Reispflanzen. Aus den weissen Reiskörnern entstehen wieder weisse Keimlinge, aus gestreiften Körnern weisse, gestreifte und grüne Pflanzen, und aus den grünen Körnern meist nur grüne Pflanze.

7. Die Farbe der Rispen der gestreiften Reispflanzen ist mosaikförmig wechselnd, es ist auch daher die Verteilung der verschieden gefärbten Körner auf der Rispe mosaikartig. Infolgedessen ist die Verteilung derjenigen Körner auf der Rispe mosaikartig, aus welcher weisse, gestreifte und grüne Pflanzen hervorgehen.

8. Die Erscheinung der weissen Streifen der Reispflanzen gehört zu den nicht mendelnden Buntblättrigkeiten. Sie wird durch die Mutter d. h. das Zellplasma der Eizellen vererbt.

Autoren.

33. Über die Anwendung der *Mimosa pudica* als Indexpflanze zur Bestimmung des Wasserhaltungsvermögens verschiedener Bodenarten in Beziehung auf das Welken der Pflanzen. Riichirô KÔKETSU. [Bot. Mag. Tôkyô 39, 1925, 152-158].

Eine neue Prozedur für die Bestimmung der Wassermenge, welche noch nach dem Welken der darin bewurzelten Pflanzen in dem Boden hintergelassen wird, ist hier veröffentlicht. Zur Bestimmung des betreffenden Wassergehaltes oder des Wasserhaltungsvermögens des Bodens ist es natürlich notwendig, dass man einen bestimmten kritischen Punkt des Welkens der benutzten Pflanze möglichst exakt finden kann. Weil *Mimosa pudica* einen leicht und deutlich wahrnehmbaren kritischen Zustand in dem Verlauf des Welkens aufweist, so mag diese Pflanze als eine gute Indexpflanze für

unseren Zweck brauchbar sein. Während des Welkungsverlaufes geht nämlich die Verminderung der gegen Reize reagierenden Fähigkeit dieser Pflanze mit dem Fortschritt des Welkens Hand in Hand, bis die Reagierbarkeit aller primärer, sekundärer und tertiärer Blattgelenke gegen möglichst starke Stossreize nicht mehr bemerkbar geworden ist. Das Auftreten dieses Zustandes ist ein leicht bestimmbarer kritischer Punkt des Welkens dieser Pflanze. Um die Frage zu lösen, ob dieser Punkt als ein Anhaltspunkt für Studien des Wasserverhältnisses im Boden anwendbar ist, wurde eine Reihe der Experimente ausgeführt.

Die Experimente wurden mit zehn verschiedenen Bodenarten gemacht. Nach den Versuchsergebnissen schwankte der Wassergehalt an dem betreffenden Punkt, welcher in ein und derselben Bodenart gefunden war, stets nur wenig, obwohl derselbe in den verschiedenen Bodenarten natürlich graduell voneinander verschiedentlich vorkam. Mit anderen Worten wurde dadurch die Anwendbarkeit dieser Methode für Studien des Wasserverhältnisses zwischen den Pflanzen und den verschiedenen Böden gut nachgewiesen.

Verfasser.

34. Über die Brauchbar- und Zweckmässigkeit der "Pulvermethode" für die Bestimmung des Wassergehaltes im Pflanzenkörper. Riichirô KÔKETSU. [Bot. Mag. Tôkyô 39, 1925, 169-175].

Für die Bestimmung des Wassergehaltes im Pflanzenkörper ist es durch eine Reihe der Experimente konstatiert, dass die sog. Pulvermethode, eine Methode, den Stoffgehalt im Pflanzenkörper durch die Bestimmung des Gehaltes in einem bestimmten Volumen Gewebepulver zu schätzen, auch hierbei zweckmässig brauchbar ist. Dass diese Methode bedeutend zweckmässiger ist als die gewöhnlichen prozentuellen Bestimmungsmethoden, wird besonders da aufmerksam, wo die stoffliche Zusammensetzung der Versuchsmaterialien weit voneinander abweicht.

Verfasser.

35. Über den Einfluss der Frucht auf die Samenreife bei einigen Kulturpflanzen. Hiroshi KOSAKA. [Jour. Dept. Agric. Kyushu Imp. Univ. 1, 1925, 197-216].

Obwohl man über die Bedeutung der Früchte für den Samenschutz oder die Samenverbreitung spricht, pflegt man nur wenig auf ihre Bedeutung für die Samenreife die Aufmerksamkeit zu lenken. Deshalb hat der Verf. diesbezügliche Erscheinungen zu studieren unternommen, und zwar an den Früchten von *Capsicum annuum*, *Solanum Melongena* und *Cucumis sativus*.

Die Früchte in den verschiedenen Reifegraden wurden, teils auf den Mutterpflanzen belassen, teils davon ausgetrennt, geerntet. Daraus wurden die Samen sofort oder erst nachdem die Früchte während einigen Tagen im Zimmer oder draussen im sonnigen Orte gelagert waren, gesammelt. In jedem Falle, sogleich nach der Sammlung der Samen, wurden ihr Trockengewicht und ihre Keimungsfähigkeit bestimmt, um die Frage zu lösen, ob die Früchte auf den Vorgang der Samenreife etwaige Einflüsse ausüben können.

Die Farben der Früchte wurden durch die Lagerung allmählich tiefer, unabhängig davon, ob sie auf den Mutterpflanzen belassen oder von ihnen getrennt werden. Im Laufe dieses Vorganges nimmt, nicht nur das Trockengewicht, sondern auch das Keimungsprozent der darin enthaltenen Samen zu. Deshalb ist es höchst wahrscheinlich, dass sogar bei den von den Mutterpflanzen ausgetrennten Früchten eine Stoffwanderung aus den letzteren in die Samen sowie eine Steigerung der Keimungsfähigkeit derselben stattfinden. Bei den Samen, welche der Kontrolle halber nach der Ernte ausserhalb der Früchte gelagert wurden, kann man ebenfalls die Zunahme der Keimungsfähigkeit

wahrnehmen, wenn in geringerem Grade als bei dem soeben genannten Falle.

Verfasser.

36. The Vegetation of Yezo. Yûshun KUDO. [Japan. Jour. Bot. **2**, 1925, 209-292].

37. On the Staining Reaction of the Spermatozoids and Egg Cytoplasm in *Cycas revoluta* (Preliminary note). Yoshinari KUWADA. [Bot. Mag. Tôkyô, **39**, 1925, 128-132].

Certain contrasts were found in staining reaction between the spermatozoids and egg cytoplasm in *Cycas revoluta*. When spermatozoids or eggs cut in sections were treated first with a solution of iron chloride and then, after being washed, with a solution of potassium ferrocyanide, the spermatozoids became blue, while the cytoplasm of the eggs remained unstained. When the reagents were used in the reversed way, the results seemed to show another contrast, in which the spermatozoids remained unstained and the egg cytoplasm was stained blue. Other contrasts between these sex cells were also found with neutral violet extra and rongalitweiss.

Author.

38. On the Number of Chromosomes in Maize. Yoshinari KUWADA. [Bot. Mag. Tôkyô, **39**, 1925, 227-234, 4 figs.].

In reply to the paper of KIESSELBACH and PETERSEN, the author re-examined one of his old preparations and confirmed his earlier results. His conclusion is that he agrees with the results of KIESSELBACH and PETERSEN obtained from American corns, but he does not think that they furnish a reason to suspect the higher chromosome numbers of certain strains to have been miscounted.

Author.

ADDITION BY THE AUTHOR.—After this paper had been published, a paper of LONGLEY (Science, 1925), whose early chromosome determinations in maize were in agreement with those of KIESSELBACH and PETERSEN reached the author's hand. In it LONGLEY states that he found four strains, two sweet and two starchy, which are characterized by $21\frac{1}{2}$, 11, $23\frac{1}{2}$, 12 and even 13 haploid chromosomes at diakinesis, numbers which substantiate this phase of the author's results.

39. On the Alkaloids of Japanese Species of *Aconitum* L. (Japanese). Rikô MAJIMA, Harusada SUGINOME and Moriiti MORIO. Sendai, 1925, 133 pp.

40. Flora of Japan. (Japanese). Tomitarô MAKINO and Kwanzi NEMOTO. Tôkyô, 1925, 1924 pp.

A first complete flora of Japan ever made, where the Phanerogams and Vascular Cryptogams of whole Japan (incl. Sachalien, Loochoo and Formosa, except Corea) are described, 10212 species in total. Plants are arranged according to the system of ENGLER, though the order of families is just the reverse, beginning with the Compositae.

41. Studies on Purple Speck of Soybean Seed. Takashi MATSUMOTO and Ryokichi TOMOYASU. [Ann. Phytopathol. Soc. Japan, **I**, 6, 1-14, 1 pl. and 3 figs.].

The purple speck on soybean seed, which was sometimes considered to be a disease due to climatic conditions, is due to the action of a new fungus, which the authors call *Cercospora Kikuchii*. It attacks not only seeds, but also leaves, stems and pods. The authors have done the cultures on several nutrient media. On the glucose media it turns the solutions purple. The watery extraction of mycelia of the fungus grown on

glucose media exhibits a similar color. This pigment becomes red with acid, and exhibits pale greenish discoloration after a few minutes by the addition of alkali; it is insoluble in ether, petrol ether, chloroform, benzine, turpentine oil and carbon bisulphide. Mycelial extraction in alcohol exhibits bright red color, which becomes rich green with alkali and red with acid. This pigment is soluble in ether, chloroform, acetone and turpentin but insoluble in benzine, carbon bisulphide, petrol ether and water.

According to the results of the inoculation experiments there are various degrees of susceptibility to the disease in different varieties. It is noticed that the early varieties are more susceptible than the late ones.

42. *Gibberella Saubinetii* (Mart.) Sacc. as a Causal Fungus of the Wilt-disease of Horse-bean. Chûichi MIYAKE. [Ber. Ôhara Inst. landw. Forsch. **2**, 1924, 435-442, 2 pls.].

The wilt-disease of Horse-bean (*Vicia Faba* L. var. *equina* PERS.) is caused by a number of fungi, and especially by *Gibberella Saubinetii*. In this paper the author presents the results of his studies on the morphology of this fungus and of its culture on various media. The optimum temperature for its growth lies near 30°C.

43. Botanische Beobachtungen in Japan. III. Mitteilung. Über das Leuchten des Schlachtviehfleisches in Sendai, Japan. Hans MOLISCH. [Sc. Rpts. Tôhoku Imp. Univ. IV. Ser. (Biology), **1**, 1925, 97-103].

Der Verf., der früher in Europa seine Beobachtungen über das Leuchten des Fleisches gemacht hatte, hat in dem vorliegenden Aufsätze die Resultate seiner in Sendai ausgeführten über das gleiche Thema mitgeteilt. Die Fleischstücke wurden in der 3-prozentigen Kochsalzlösung so gelegt, dass sie daraus grösstenteils in die Luft ragen. Bei den von ihm untersuchten Rindfleischproben wurde 55 % und bei den Schweinefleischproben 15 % aufzuleuchten gefunden. Bei den ohne Kochsalzlösung aufbewahrten Fleischstücken tritt das Leuchten sehr selten auf. Durch die Reinkulturen von verschiedenen Proben zeigte es sich, dass bei dieser Lichtentwicklung stets eine und dieselbe Bakterienart-*Bacterium phosphoreum* (COHN) MOLISCH tätig ist, d. h. dieselbe, welche auch in Europa den gleichen Vorgang veranlasst.

Zum Schlusse weist der Verf. auf Grunde verschiedener Beispiele auf den Kosmopolitismus der Mikroorganismen hin.

44. Botanische Beobachtungen in Japan. IV. Mitteilung. Über das massenhafte Vorkommen von Eiweisspindeln in einer Vaucheria. Hans MOLISCH. [Sc. Rpts. Tôhoku Imp. Univ. IV. Ser. (Biology), **1**, 1925, 105-110, 1 Taf.].

In den Zellen einer unbekannten Art von *Vaucheria* hat der Verf. zahlreiche farblose Spindeln aufgefunden, die mit einander zu mehr oder minder grossen strahligen Haufen verbunden sind. Jede Spindel beträgt 15μ in der Länge und hat eine Breite von 3.5μ in der Mitte. Nach ihren chemischen Reaktionen sind sie hauptsächlich als ein eiweissartiger Körper aufzufassen; dabei ist auch das Vorhandensein eines andern Körpers, der dem Phloroglucin oder den Gerbstoffen nahe steht, wahrscheinlich. Die oben erwähnten Eiweisspindeln wurden fast regelmässig im Herbst gefunden, hingegen niemals im Frühjahr.

Der Verf. erwähnt noch seine Entdeckung eines andern Inhaltskörpers, welcher aus vielen unregelmässigen Körnchen von schmutzig bräunlicher Farbe besteht. Seine chemische Natur ist noch unklar, wenn er vielleicht ein Derivat des Chlorophyllfarbstoffes darstellen dürfte.

45. Botanische Beobachtungen in Japan. V. Mitteilung. *Mycoidea parasitica* Cunningham, eine parasitische und *Phycopeltis epiphyton* Millard., eine epiphyllle Alge in Japan. Hans MOLISCH. [Sc. Rpts. Tôhoku Imp. Univ. IV. Ser. (Biology), **1**, 1925, 111-118, 1 Taf.].

Eine parasitische Chroolepidee, welche höchst wahrscheinlich mit der in Indien entdeckten *Mycoidea parasitica* CUNNINGHAM identisch ist, wurde auch in Japan auf den Blättern von *Camellia* und *Eurya* aufgefunden. Sie bildet an der Oberseite des Blattes runde, etwas erhabene Flecke von verschiedener Grösse aus. Ihre Farbe ist grau im alten Exemplare und graugrün an der Peripherie im jüngeren. Die mikroskopische Untersuchung lehrt uns, dass die Alge die Kutikula abgehoben und zwischen derselben und Epidermis sich entwickelt hat. Sie tötet zunächst die Epidermiszellen, dann die Pallisadenparenchymzellen und kann weiter das Absterben des Mesophylls bis zum untern Epidermis veranlassen. Als eine weitere Folge der Einwirkung der Alge ist die Entwicklung der ringartigen Verdickungen der Pallisadenzellwand zu erwähnen, welche auf dem Querschnitt der Blätter eine parallel zum Epidermis fortlaufende Linie bilden.

Phycopeltis epiphyton MILLARDET, welche bisher bloss an gewissen Gegenden Europas erwähnt wird, wurde auch in Japan aufgefunden, und zwar auf den Blättern von *Aucuba japonica*, *Pisania*, *Litsea*, *Camellia*, *Sarcocochilus*, einigen Farnen, *Lycopodium* und auch auf einem Laubmoos *Rhizogonium Dozyanum*.

46. Botanische Beobachtungen in Japan. VI. Mitteilung. *Pseudoplasmodium aurantiacum* n. g. et n. sp., eine neue Acrasiee aus Japan. Hans MOLISCH. [Sc. Rpts. Tôhoku Imp. Univ. IV. Ser. (Biology), **1**, 1925, 119-121, 1 Taf.].

Auf faulenden Blättern von *Zostera marina* und Bakterienhäuten im Glasschale mit Meereswasser fand der Verf. eine Acrasieeart, welche ein in der Mitte geschlossenes und in der Peripherie in ein unregelmässiges Netz von Ästen ausgehendes Plasmodium bildet. Das letztere wird aus einer mehr oder minder grossen Anzahl von den spindelförmigen Myxamöben zusammengesetzt, welche nicht selten ihre Verbindung durch je einen Plasmafaden erkennen lassen. Kein bestimmt geformter Fruchtkörper wird ausgebildet, sondern statt dieser ein grosser Haufen von sich abrundenden Myxamöben, welche als Sporen aufgefasst werden können. Dieser Haufen ist von orangeroter Farbe, was davon herrührt, dass jede ihn zusammensetzende Zelle 1-3 orangefarbene Körnchen enthält, welche die Karotinreaktion geben. Keine Myxoflagellaten kommen zur Ausbildung, woraus der Verf.'s Annahme, dass wir dabei mit einer Acrasieeart zu tun haben.

47. Botanische Beobachtungen in Japan. VII. Mitteilung. Über wachsliebende (cerophile) Pilze. Hans MOLISCH. [Sc. Rpts. Tôhoku Imp. Univ. IV. Ser. (Biology), **1**, 1925, 123-133, 1 Taf.].

Bei manchen Bambusen tritt knapp unterhalb des Knotens ein dunkler Ring auf, welches nicht selten von einem unbekannten sterilen schwärzlichen Pilz herrührt, z. B. bei *Arundinaria Chino*. Die Wachskruste umsäumt den Stengel in Form eines Ringes und der schwarze Pilz siedelt sich an diesem Orte an, um dort seine Nahrung zu bekommen. Das Pilzmyzel besteht aus verzweigten, zu einem unregelmässigen Netz vereinigten Fäden, die sich aus rundlichen Zellen zusammensetzen oder der Pilz bildet mit seinen Fäden eine geschlossene Haut von Pseudoparenchym. Es ist dem Verf. gelungen, diesen Pilz auf des Wachspapier rein zu züchten. Es ist dabei bemerkenswert, dass das gelbe Wachs als Nährboden zu einer elektiven Kultur der cerophilen Pilze führt, indem darauf sie ausschliesslich allein oder fast allein das Feld behaupten können.

Der Verf. konnte auch auf den Zweigen von *Acer rufinerve*, *Lindera umbellata* und

Daphniphyllum macropodium (bei dem letzteren auch an der Unterseite des Blattes) den wachsliebenden Pilz nachweisen und ihn auf das Wachs rein züchten.

48. Botanische Beobachtungen in Japan. VIII. Mitteilung. Die Eisenorganismen in Japan. Hans MOLISCH. [Sc. Rpts. Tôhoku Imp. Univ. IV. Ser. (Biology), **1**, 1925, 135-168, 4 Tafeln u. 2 Textfig.].

I. Nach den Verf.s Beobachtungen sind in ganzen Japan die Eisenbakterien sehr weit verbreitet, und zwar ganz besonders in den berieselten Reisfeldern. Meistens hat er *Chlamydothrix ochracea* gefunden, oft mit *Gallionella ferruginea* vermengt. Als die Epiphyten auf verschiedenen Wasserpflanzen sind *Siderocapsa Treubii*, *Cladothrix dichotoma*, *Chlamydothrix sideroporus* usw. vertreten, wenn er niemals den in Europa sehr häufigen *Crenothrix polyspora* angetroffen hat. Ausser den oben erwähnten Bakterien hat der Verf. auch viele andere Organismen hervorgehoben, welche bei der Präzipitation des Eisens in der Natur eine mehr oder minder grosse Rolle spielen, z. B. viele Algen, wie *Oedogonium*, *Characium*, *Closterium*, *Pleurotaenium*, *Surirella*, *Anabaena*, *Cocconeis* (Manganorganismen!) die Flagellaten, wie *Anthophysa*, *Spongomonas*, *Lagynion*, *Trachelomonas*, *Rhipidodendron*, einige niedere Tiere, wie das auf den Wasserblättern von *Salvinia natans* epiphytisch lebenden Rädertier *Meliceria ringens* usw., das Laubmoss *Fontinalis antipyretica*, die Phanerogamen, wie *Trapa natans*, *Hydrilla* und Reispflanze.

II. Die Blätter von *Potamogeton* sind im lebenden Zustand sehr gerbstoffreich. Nach ihrem Tode ist das in die toten Zellen eintretende Eisen als gerbsaures Eisen gefällt und es kommt schliesslich zu einer so erstaunlichen Eisenanhäufung, dass die Blätter ganz schwarz werden und beim Verbrennen Eisenskelette hinterlassen.

III. Vor einigen Jahren hat HARDER die Tatsache nachgewiesen, dass in den Lösungen von zitronensaurem Eisen-Ammon die Eisenoxydhydratfällung stattfindet, wenn sie nicht sterilisiert wurden, und doch konnte er dabei keine Spur von Eisenbakterien finden, ausgenommen den Fall, wo das Wasser der Eisenquelle als Lösungswasser gebraucht wurde. Der Verf. hat die Experimente HARDERS wiederholt und konnte im allgemeinen seine Angabe bestätigen, doch weichen die Verf.s Resultate von denen HARDERS ab, insofern als der Verf. bei den nicht sterilisierten Lösungen immer das Auftreten der Eisenbakterien nachweisen konnte. Da es nicht ausgeschlossen wäre, dass bei seinen Versuchen Schimmelpilze tätig sein könnten, hat der Verf. die gleichartige Versuche mit *Penicillium* und *Aspergillus* ausgeführt, wobei er niemals die Fällung des Eisenoxydhydrates erkennen konnte. Somit ist die Eisenfällung der Hauptsache nach eine extrazelluläre und erfolgt durch Bakterien, wie der Verf. ausgedrückt hat.

49. Botanische Beobachtungen in Japan. IX. Mitteilung. Über die Symbiose der beiden Lebermoose *Blasia pusilla* L. und *Cavicularia densa* St. mit *Nostoc*. Hans MOLISCH. [Sc. Rpts. Tôhoku Imp. Univ. IV. Ser. (Biology), **1**, 1925, 169-188, 2 Tafeln].

Die Symbiose zwischen *Blasia pusilla* und *Nostoc* ist seit langem bekannt, wenn die Frage, wie sie aufzufassen ist, noch experimentell unbeantwortet bleibt. Der Verf. hat bei *Blasia pusilla* nie die *Nostoc*-Kolonien vermisst, welche längs des Thallusrandes an beiden Seiten je eine Reihe von schmutzig grünen Punkten bilden: sie füllen die Blattohren ganz aus, in Verein mit den eigentümlichen verzweigten Schläuchen. Bekanntlich gibt es bei *Blasia* zwei Arten Brutkörper, nämlich die an den flaschenförmigen Behältern befindlichen und die an der Thallusoberfläche frei sitzenden ("Stemmschuppen"); die letzteren sind immer mit *Nostoc* infiziert, die ersteren niemals. Es gelang dem Verf., die aus *Blasia* befreiteten *Nostoc*kolonien rein zu züchten, dagegen trotz vieler Mühe war

es ihm unmöglich, die *Nostoc*-freie *Blasia* (auch *Cavicularia*) zu bekommen. Weiter hat der Verf. die Kulturexperimente von den *Blasia-Nostoc* auf den Nährboden mit oder ohne N gemacht, und er konnte die Tatsache feststellen, dass diese Cyanophyceen in beiden gleichgut gedeiht. Da es nicht unmöglich sein dürfte, dass *Nostoc* seinen Stickstoff aus dem Agar in den Nährmedien oder aus dem in der Luft vorhandenen Ammoniak beziehen könnte, hat der Verf. eine Reihe von Versuchen ausgeführt, um solche Möglichkeiten zu prüfen, deren Resultate immer negativ ausgefallen sind, worauf der Verf. zum Schlusse kommt, dass die *Blasia-Nostoc* tatsächlich den freien Luftstickstoff assimilieren kann.

Betreffend *Cavicularia densa* konnte der Verf. auch die *Nostoc*-kolonien auf den Thallus und den den Stemschuppen von *Blasia* entsprechenden Brutkörper nachweisen. Er hat die Reinkultur von *Cavicularia-Nostoc* bekommen und dabei konnte er auch die Assimilation des freien Luftstickstoffes wahrnehmen.

Die Verf.'s Schlüsse über die in Frage stehenden Symbiose sind wie folgt: Die *Nostoc*-Alge findet in dem Lebermoos einen Schutz gegen Eintrocknung, während sie als Gegenleistung dem Lebermoos den von ihnen bereiteten gebundenen Stickstoff gibt.

50. On the Chemical Constituents of *Matteucia orientalis* (Hk.) Trev. Tetuzi MUNESADA. [Ber. Ôhara Inst. landw. Forsch. **2**, 1924, 429-434, with figs.]

51. Critical Notes of Japanese Ferns, with Special References to the Allied Species. Takenoshin NAKAI. [Bot. Mag. Tôkyô, **39**, 1925, 101-121].

This paper is the result of the comparative study of the Japanese Pteridophyta and the foreign, which the author has made chiefly in the Herbarium of Muséum d'Histoire naturelle de Paris. The main subjects are as follows.

1. Critical study of all known species of the genus *Woodwardia*, containing the distinction of Asiatic *Woodwardia radicans* from the European; distinction of *Woodwardia prolifera* from *W. orientalis*; distinction of *Woodwardia auriculata* from *W. radicans*, etc.
2. Critical study of all known species, varieties and forms of the genus *Pteridium*, containing a new variety *Pteridium aquilinum* var. *jeponicum*.
3. *Asplenium macrocarpum* recorded from Japan is *Athyrium Vidalii*, comb. nov.
4. *Diplazium Conilii*, comb. nov.
5. Critical notes of the varieties and forms of *Polystichum aculeatum*.
6. *Cyrtomium acutidens* CHRIST is a form of *Polystichum falcatum*.
7. *Polystichum falcatum* var. *macropterum* is a variety of *P. caryotideum*.
8. *Aspidium anomophyllum* ZENKER is a species of *Polystichum* allied to *P. falcatum*, and *Polystichum miyajimense* is one of its varieties.
9. *Cyrtomium Fortunei* was transferred to *Polystichum*.
10. *Polystichum lobatum* var. *chinense* CHRIST is a new species *P. neolobatum*.
11. *Polystichum pacificum* n. sp. is allied to *Polystichum varium*.
12. *Aspidium lacerum* var. *ambigens* was transferred to *Dryopteris erythrosora* as one of its varieties.
13. *Davallia bullata* recorded from Japan, Corea and Shangtung is *D. Mariesii* MOORE.

Author.

52. Notes on Japanese Ferns II. Takenoshin NAKAI. [Bot. Mag. Tôkyô, **39**, 1925, 176-203].

This paper is also the result of the studies on the Japanese Pteridophyta which the

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author made in the Muséum d'Histoire Naturelle de Paris. It includes the following subjects.

1. *Physematum* is distinct from *Woodisia*; *Woodisia polistichoides* represents a new section *Aerolysis* of *Woodisia*; new combination of *Physematum manchuriense*.
2. *Vittaria formosana*, n. sp.
3. The distinction of *Mertensia dichotoma* from *M. linearis*. The explanations of the allied species of the latter. *Mertensia spissa* var. *pubigera*, comb. nov. *Mertensia hawtiensis*, nom. nov.; *Mertensia discolor* var. *linearis*, var. nov.
4. *Gleichenia Ichisiana* is a synonym of *Mertensia laevissima* comb. nov. (*Gleichenia*).
5. Existence of *Lygodium microstachyum* in Formosa.
6. *Azolla japonica*, and its difference from the known species of *Azolla*.
7. *Azolla imbricata*, comb. nov.
8. Critic on the nomenclature of *Marsilea*.
9. *Botrychium boreale* and *Botrychium robustum* as the new additions to the Japanese and Korean Flora.
10. *Ophioglossum nipponicum* nom. nov., *Ophioglossum pedunculatum* DESVAUX.
11. New additions to the Japanese Flora: *Equisetum palustre* var. *japonicum*, var. nov.; *Equisetum palustre* var. *samulosum* MILDE; *Equisetum hiemale* var. *Schleicheri* MILDE; *Equisetum limosum* var. *aphyllum* ROTH; *Equisetum limosum* var. *verticillatum* DOELL; *Equisetum ramosissimum* var. *glaucum* var. nov.; *Lycopodium serratum* f. *intermedium* n. f.; *Lycopodium clavatum* var. *nipponicum* var. nov.; *Lycopodium clavatum* var. *robustius* var. nov.; *Lycopodium clavatum* var. *monostachyum* DESVAUX; *Lycopodium clavatum* var. *Wallichianum* SPRING; *Lycopodium lucidulum* MICHAUX; *Lycopodium Wightianum* WALLICH; *Selaginella philippica* SPRING.
12. The distinction of *Selaginella japonica* MIQUEL from *S. Kraussiana*. Author.

53. Über die Keimungsfähigkeitsdauer der Reiskörner. (Japanisch). Yôzô NAKAJIMA. [Bot. Mag. Tôkyô, 39, 1925, (307)–(321)].

Die Keimungsfähigkeitsdauer der vom Verf. untersuchten Reiskörner beträgt 2–4 Jahren. Um den Einfluss verschiedener Luftfeuchtigkeit auf die Keimungsdauer zu untersuchen wurden sie auf die Räume mit Schwefelsäure von verschiedenen Konzentrationen aufbewahrt. Danach erniedrigt reine Schwefelsäure die Keimungskraft bedeutend und zwar schon nach drei Monaten; auch die auf 25 % Schwefelsäure aufbewahrten Körner haben schon nach einem Jahre ihre Keimungskraft um 48 % eingebüßt. Diejenige, welche auf 50 % Schwefelsäure aufbewahrt wurden, haben ihr Keimungsvermögen am längsten beibehalten, denn sogar nach sechs Jahren beträgt es noch 45 %. Das Gemisch, welches aus reinem Glycerin und Kalziumchlorid (CaCl_2 100 gr + H_2O 25 ccm) besteht kann man auch benutzen statt 50 % Schwefelsäure mit ganz gleichen Resultaten.

54. Über die Bedeutung der Brettwurzel. (Japanisch). Harufusa NAKANO. [Bot. Mag. Tôkyô, 39, 1925, (159)–(164), 1 Textabbild.].

In der vorliegenden vorläufigen Mitteilung zeigt der Autor zunächst, dass die Brettwurzel von Nadelhölzern (*Cryptomeria* und *Pinus*) im wesentlichen hyponastisch (hypotrophisch), und die von Laubhölzern (vor allem von *Oeltis sinensis* und *Aphananthe aspera*) epinastisch ist. Er glaubt, dass sowohl epi-, als auch hyponastisches Dickenwachstum irgend einer Wurzel diese nach oben, also nach einer weniger widerstandsfähigen Stelle emporhebt, bis eine Brettwurzel dadurch entsteht. Dabei muss natürlich die Widerstandsfähigkeit des Bodens wirksam sein. Nach eigenen Beobachtungen des Autors liegt merkwürdigerweise diejenige Seite des Baumes, wo die Brettwurzel am stärksten

entwickelt ist, derjenigen welche der grössten Belastung der Blätterkrone ausgesetzt ist, ganz gegenüber. Diese neue Beweisführung dürfte darauf hinweisen, dass die Entwicklung einer Brettwurzel stark durch die Belastung der gegenüberliegenden Blätterkrone befördert wird. Das Licht kann vielleicht dabei indirekt einwirken, indem es die Entwicklung der Blätterkrone beeinflusst. Bei windgeschorenen Bäumen an der Seeküste muss die Seite mit der grössten Brettwurzel vorwiegend durch die dort herrschende Windrichtung bestimmt werden.

Ausserdem diskutiert der Autor theoretisch, dass die Brettwurzel stark die mechanische Widerstandsfähigkeit eines Baumes erhöhen könnte, und er denkt, dass die der grössten Belastung entgegenstehende Brettwurzel dabei am wirksamsten ist. Autor.

55. Morphological and Physiological Studies on a *Helminthosporium* found on *Leptochloa chinensis* Nees. Yosikazu NISIKADO and Chûichi MIYAKE. [Ber. Ôhara Inst. landw. Forsch. **2**, 1924, 473-490, 1 pl. and 2 figs.].

A new species of *Helminthosporium* was found on leaves of *Leptochloa chinensis*, which the authors call *H. Leptochloae*. In this paper the morphological characters of the fungus as well as the biometrical characters of its conidia are presented. Inoculation experiments were tried on twenty species of grasses: *Leptochloa chinensis* only was found to be susceptible, while many others were quite immune or very resistant. The PH value for the growth of the fungus is 2.6-10.9, and the best growth takes places between 7.4-9.1.

56. Über ein neues *Helminthosporium* auf *Panicum Crus-Galli* L. Yosikazu NISIKADO und Chûichi MIYAKE. [Ber. Ôhara Inst. landw. Forsch. **2**, 1925, 597-612, 1 Taf.].

Eine neue *Helminthosporium*art, welche die Blattfleckenkrankheit von *Panicum Crus-Galli* verursacht, wurde von einigen Jahren von den Verff. entdeckt und *H. Crus-Galli* genannt, wenn es noch nicht zur Veröffentlichung angekommen ist. Der Pilz ist offenbar mit dem währenddessen von DRECHSLER veröffentlichten *H. monoceras* identisch. Die Verff. haben die Reinkultur dieses Pilzes in verschiedenen Medien ausgeführt. Die PH-Wertgrenze seines Wachstums beträgt 2,75-8,97, während das Optimum 6,83 ist.

57. A Study of the Inheritance of the Shooting Time in Rice-plant. (Japanese). Morihisa NOMURA and Riiti YAMAZAKI. [Jap. Jour. Genetics, **3**, 1925, 112-130].

Under the shooting time the authors mean the number of days which elapse between the sowing of seeds and the escape of the first panicle from the leaf-sheath. The authors have done the two kinds of crosses of the late and the early shooting races, and studied the behaviour of the F_1 to F_3 generation. In F_1 the shooting has taken place a few days later than in the late parent. In F_2 the two distinct types, one early and the other late, appeared in the ratio 1:3, the early and the late plants of each group being on average somewhat earlier and later than the respective parents. The F_3 offspring derived from the F_2 early type showed the monomodal narrow variation; those derived from the F_2 late type were distinguishable into two groups, of which the one shows the narrow monodal variation, while the other has segregated again into 1 early: 3 late. The results of the experiments have led the authors into the following conclusions about the factorial composition:

Cross No. 1. $AAbbcc \times aabbCC$ (early \times late)

„ 2. $aabbCC \times aaBBcc$ (late \times early)

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When all these factors are absent the shooting time was found to be either 91 (1921, 1922) or 100 days (1923). Each of the factors *A*, *B* and *C* prolongs the shooting time to a certain extent, *C* being most and *B* least efficacious in this respect. By the combination of either *A* and *C* or *B* and *C* the shooting time becomes longer.

58. On the Structure of *Cyathea spinulosa*, WALL. (Japanese). Yudzuru OGURA. [Bot. Mag. Tôkyô, **39**, 1925, (1)-(28), 9 figs.].

The author has made the anatomical investigation on the vegetable organs of the adult and young materials of *Cyathea spinulosa*, from a southern island of Japan. He makes the serial successive sections of stems, leaves and roots, and constructs a solid model to show the stelar formation, the arrangement and the form of the leaf-gaps, the mode of branching of the leaf-traces and root-traces, and the courses of the medullary bundles.

The stele of the stem, surrounded by the sclerenchymatous sheath, is constructed as a dictyostelic type with long fusiform leaf-gaps which always overlap each other. Leaf-traces, numerous in number, depart from the both margins of each gap, and after entering the petiole, arrange in two series, upper and lower. Though the bundles in each series unite in a band form, both series do not meet until the very end. Root-traces depart from the lower half of gap-margins. Medullary bundles appear suddenly in the pith in pair, and ascending through the pith, fuse to the base of leaf-traces. Before the fusion they usually bifurcate or trifurcate, and in this case these branches unite to the leaf-traces belonging to the upper series. The whole length of a medullary bundle is equal to the distance between two gaps in a vertical row.

From the anatomical studies of this plant, especially of the medullary bundles, it is found that the construction of the stele is not the polycyclic dictyostele found in Polypodiaceae and Marattiaceae, but is a type not described before, and the author suggests for this type the name "Cyathean Dictyostele." Author.

59. On the Structure of *Alsophila Ogurae*, HAYATA. (Japanese). Yudzuru OGURA. [Bot. Mag. Tôkyô, **39**, 1925, (197)-(213), 5 figs.].

The author has made an anatomical research of *Alsophila Ogurae*, a new species of tree ferns found in the Bonin Islands.

The general construction of this plant is similar to that of *Cyathea spinulosa*, but simpler than in the latter.

The most interesting point in this plant lies in the medullary bundles. In the adult plant they appear in the pith and ascend through it, until they are fused to the meristele in connection with leaf traces. In the young plant, there are two ways for their origin: the one is by the independent formation within the pith, as in the case of the adult plant, the other by the internal projection of the meristele, as in the case of a polycyclic stele. The last way occurs only in the youngest part. It is assumed that the "Cyathean Dictyostele" may be derived from a kind of the polycyclic stelar forms. Author.

60. Klassifikation der Wurzelknöllchenbakterien in den in Japan als grüne Dünger benutzten Leguminosen nach ihren Immunserumreaktionen. I. Mitteil. (Japanisch). Sirô ÔKAWARA. [Aso und seine Mitarbeiter, Mitteil. über die Untersuchungen betreffend den praktischen Gebrauch des von den Bakterien aufgenommenen freien Stickstoffes, **2**, 1925, 1-18].

Die an den Wurzelknöllchen von *Pisum sativum*, *P. arvense*, *Vicia Faba*, *V. hirsuta*, verschiedenen Rassen von *V. sativa* (z. B. Saatwicken) befindlichen Bakterien stimmen

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in ihren verschiedenen Merkmalen (Gestalt, Grösse, Färbung usw.) zueinander fast ganz überein und sind somit damit von einander kaum unterscheidbar. Doch nach den in der Serodiagnostik üblichen Agglutinations- sowie Komplementbindungsmethoden konnte der Verf. sie unter drei Klassen einreihen, nämlich, I. Bakterien aus *Vicia Faba*, *Pisum arvense* und 4 Rassen von *Vicia sativa*, II. dieselben aus *Pisum sativum* und 2 anderen Rassen von *Vicia sativa*, und III. dieselben aus *Vicia hirsuta*. Autor.

61. Klassifikation der Wurzelknöllchenbakterien in den in Japan als grüne Dünger benutzten Leguminosen nach ihren Immunserumreaktionen. II. Mitteil. (Japanisch). Sirô ÔKAWARA und Ryôzô YOSIDA. [Aso, Mitteil. über die Untersuchungen betreffend den praktischen Gebrauch des von den Bakterien aufgenommenen freien Stickstoffes, **2**, 1925, 19-30, 1 Tabelle].

Die Verf. haben aus 15 Stücken von *Pisum sativum* und 7 von *P. arvense* die Reinkulturen von Knöllchenbakterien bekommen. Auf Grunde der Resultate der Agglutinationsuntersuchungen konnten sie die Tatsache feststellen, dass unter den Bakterien aus der erstern Art es im ganzen vier und denselben aus der letzteren drei serodiagnostisch unterscheidbare Sorten gibt. Weiter zeigte es sich durch die Agglutinationsexperimente der Bakterien aus beiden *Pisum*arten untereinander, dass einige Sorte Bakterien aus *P. sativum* serodiagnostisch mit einer aus *P. arvense* völlig übereinstimmen. Autoren.

62. Klassifikation der Wurzelknöllchenbakterien in den in Japan als grüne Dünger benutzten Leguminosen nach ihren Immunserumreaktionen. III. Mitteil. (Japanisch). Sirô ÔKAWARA und Ryôzô YOSIDA. [Aso, Mitteil. über die Untersuchungen betreffend den praktischen Gebrauch des von den Bakterien aufgenommenen freien Stickstoffes, **2**, 1925, 31-41].

Die Verf. haben die Untersuchungen über die Serumreaktionen der Wurzelknöllchenbakterien aus zwei Rassen von Sojabohne, *Lupinus luteus* und *Ornithopus sativus* ausgeführt. Danach zeigte es sich, 1. dass die Bakterien aus diesen drei Arten serodiagnostisch unter drei Klassen, 2. dass dieselbe aus Sojabohnen unter zwei Klassen eingereiht werden müssen, und 3. dieselbe aus *L.* und *O.* je als zu einer einheitlichen Klasse gehörig betrachtet werden können. Autoren.

63. On the Germination of *Euryale ferox*, Salisb. Yoonosuke OKADA. [Bot. Mag. Tôkyô, **39**, 1925, 133-141, 5 text-figs.].

The seeds of *Euryale ferox* freshly collected were sown:—

- a) in a pot containing water plus a small quantity of garden turf, kept out doors
- b) the same as a), kept in a glass house
- c) in a glass vessel filled with water only, kept in a glass house
- d) in a garden pond.

Of these cultures, the materials of a), b), and d) germinated after the intervention of two winters, while those of c) showed no sign of mobilization. From these experimental results the author suggests:

1) Seeds of *Euryale ferox*, in their natural condition, seem to pass through a dormant stage of at least two winter seasons.

2) The intervention of two winter's dormant period is a necessary but not a sufficient condition to secure the germination. It must be co-operated with by some form of stimulation. Whether this factor is in the nature of reaction or of some special substance, and whether the stimulus is necessitated throughout the whole period of dormancy or it

is wanted only at the time of germination, both of these problems are left undecided.

The effect of either total or partial elimination of the seed-coat was tested but no conclusive result was attained. The author is, however, of the opinion that the mechanical resistance of the seed-coat influences but little, if any, on the delayed germination.

Lastly a brief note is annexed about the change of the form of the consecutive leaves during the early period of development. Author.

64. Further Notes on the Enzymes of *Monascus purpureus* Went. (Japanese). Kendo SAITO. [Bot. Mag. Tôkyô, **39**, 1925, (256)-(263)].

The author has once studied about the enzymes of *Monascus purpureus* WENT, and has shown that it produces protease, but not invertase. Recently HAGIWARA and AOYAMA, however, claim to have obtained a result, which is entirely contrary to that of the author. Consequently, he reinvestigated the enzymic property of this fungus, and has learnt that his own opinion is correct.

I. Invertase.

It has been ascertained that invertase is not present in it, owing to the following facts:—

- 1) The enzyme solution from it is not able to decompose cane-sugar into reducing sugars.
- 2) It does not ferment cane-sugar by LINDNER'S small fermentation method.
- 3) It is not capable of assimilating cane-sugar.

II. Protease.

Protease occurs in it, for it is proved that the enzyme solution from it, acting on Witte-peptone, Silk-peptone (HOCHST), gelatin, and casein, can decompose all of them.

[S. Japan. Jour. Bot. **2**, 1925, (46), Abstract No. 139.]

Author.

65. Studien über die Stickstofffixierung mittelst *Azotobacter*. (Japanisch). Syûiti SAITO. [Aso und seine Mitarbeiter, Mitteil. über die Untersuchungen betreffend den praktischen Gebrauch des von den Bakterien aufgenommenen freien Stickstoffes **1**, 1925, 43-48].

Durch Hinzufügung einer gewissen Menge von Substanzen, z. B. Oryzanin, Rohrzucker, anorganische und organische Salzen zu den Nährböden konnte der Verf. die Zunahme der Menge des fixierten Stickstoffes durch *Azotobacter* wahrnehmen.

66. Über die Beeinflussung des Pflanzenplasmas durch die H-Ionen in verschiedenen Konzentrationen. Tetsu SAKAMURA und Tsung-Lê LOO. [Bot. Mag., Tôkyô, **39** (1925), 61-76].

Die Untersuchung wurde angestellt bezweck den direkten Beweis der Veränderung der kolloidalen Eigenschaften des Pflanzenplasmas in verschiedenen H-Ionenkonzentrationen zu machen. *Spirogyra* wurde als Versuchspflanze gebraucht und der Grad der Verflüssigung und Verfestigung des peripherischen Plasmateils wurde mittels Zentrifugierungsmethode bestimmt.

Die Versuchsflüssigkeiten von H-Ionenkonzentrationen pH<7,0 wurden in den meisten Fällen verwendet, die wie folgt hergestellt wurden:

A	n/100 NaOH	2 ccm
	n/100 H ₃ PO ₄	verschiedene Menge (0,6-2,2 ccm)
	auf	20 ccm verdünnt
B	m/50 Na ₂ HPO ₄	1 ccm
	m/500 HCl	verschiedene Menge (0,2-10,55 ccm)
	auf	20 ccm verdünnt

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Aus einer Reihe von Versuchen ging es besonders hervor, dass die Verfestigung und die Verflüssigung der peripherischen Plasmaschichten mit der H-Ionenkonzentration nicht Hand in Hand gehen. Die beiden extremen Zustände kommen schwankend vor, und in den dazwischenliegenden H-Ionenkonzentrationen sind allmähliche Übergänge des Verflüssigungsgrades zu bemerken. Die Verflüssigung und Verfestigung treten in den Nähen von folgenden H-Ionenkonzentrationen (mit pH bezeichnet) auf:

Für den Winter- und Frühlingspflanzen.

Verflüssigung, <4,7 6,0 6,8
 4,9 6,4 7,5
 Verfestigung,

Für den Sommerpflanzen,

Verflüssigung, 4,7 5,8 7,2
 5,3 6,4 7,6
 Verfestigung,

Die Arbeiten von PEARSALL und EWING, ROBBINS u. a. in Erwägung ziehend versuchten Verf. die Versuchsergebnisse mit *Spirogyra* dadurch zu erklären, dass die zwei- oder dreigipfelige Kurve ein Resultat mehrerer Kurven der Zustandsänderungen einiger Plasmabestandteile ist. Die Verfestigungspunkte dürften die isoelektrischen Punkte darstellen, wo der Verfestigungsgrad aber durch die gegenseitige Wirkung von anderen Kolloidbestandteilen etwas modifiziert wird. Im Gegenteil dazu entspräche jeder Verflüssigungspunkt dem Kreuzpunkt dieser Kurven je zweier Plasmabestandteile. Es ist auch zu bemerken, dass die tödliche Grenzkonzentration der H-Ionen für *Spirogyra* mit derjenigen gut übereinstimmen, worin die stärkste Verflüssigung auftritt. Als eine solche Konzentration wurde pH ca 5,0 bestimmt, und der eine von Verf. (SAKAMURA) hat schon früher (1923) einen fast gleichen pH-Wert für eine andere Art *Spirogyra* gefunden.

Gestützt auf die eigenen und anderen Untersuchungen nehmen Verf. an, dass eine mässige Quellung der Plasmagallerte und eine grosse Dispersität der Plasmasole im allgemeinen die aktiven Zellentätigkeit verursachen. Trotzdem liegt es andererseits die Gefahr zu nahe, im extremen Falle derartige Zustandsänderungen des Cytoplasmas seine tödliche Deformation herbeizuführen. Wenn aber der Grad der Hydratation oder der Dispersität des Plasmas schwach ist, so ist dessen physiologische Tätigkeit nicht so merklich, während die Schädigung infolge der übermässigen Verflüssigung gar nicht stattfindet.

Den Verf. fliesst auch die Vermutung, dass bei der Verflüssigung des Plasmas von *Spirogyra*, die in den schwächer sauren Reaktion als pH 5,0 sprungweise eintritt, verschiedene physiologische Erscheinungen mässig aktiv geschehen, und dass das Protoplasma zwar dadurch nicht geschädigt wird, weil die extreme Zustandsänderung ganzen Cytoplasmas durch die Gegenwirkung anderer Plasmabestandteile gehemmt und solche Acidität des Mediums leicht hin und her verschoben wird. Autoref.

67. On the Preservation of the Pollen of Cereals. (Japanese). Takashi SASAKI. [Jour. Sc. Agric. Soc. No. 275, 1925, 259-287].

Pollen of some cereals (barley, maize) and pea was preserved for a certain duration of time under various conditions of humidity. The author has tried on such pollen, whether it will be yet able to perform the fertilization, by pollinating fresh stigmas with it and observing the consequent seed-formation. By the use of 20-100 % sulphuric acid he has got various grades of humidity. It was found that 40 % of humidity is best for the preservation of barley pollen, while for maize pollen 50 % and for pea pollen 20-40 % are most satisfactory. The author has also cultivated pollen in various nutrient

media, and studied how long it will retain its power of pollen-tube formation. He found that the duration of the preservation of its fertilizing power and that of the preservation of the power of the tube formation do not always coincide, so that the duration of the real fertilization power cannot be definitely determined, unless the actual fertilization experiment is performed.

68. Über die Beziehungen zwischen der Zellsaftkonzentration und dem Wachstum einiger Kulturpflanzen. (Japanisch). Kenkichi SATÔ. [Bult. Sc. Fak. Terk. Kjušu Imp. Univ., **1**, 1925, 247-265, 4 Textabbild].

Die Zellsaftkonzentration wurde in Intervallen von 1-2 Wochen an den Stengeln und Blättern von Buchweizen, Weizen, Gersten, Sumpfreispflanzen und *Vicia Faba* bestimmt, und zwar gewöhnlich durch plasmolytische Methode. Zugleich wurden das Längenwachstum sowie die Zunahme des Frisch- resp. Trockengewichtes bestimmt. Auf Grunde dieser Bestimmungen wurden die folgenden Verhältnisse festgestellt, 1. dass die Geschwindigkeit des Längenwachstums und die Zunahme des Trocken- resp. Frischgewichtes der Zellsaftkonzentration sich umgekehrt verhalten, und 2. dass dagegen der Gehalt der Trockensubstanz bezogen auf das Frischgewicht sowie die Abnahme des Wassergehaltes mit der Zellsaftkonzentration parallel gehen. Bei der Kultur unter physiologisch trockenen Zuständen kann nur das oben erwähnte zweite Verhältnis sich gelten; keinen umgekehrten Verlauf der Zellsaftkonzentration und des Wachstums kann man dabei bemerken.

Author.

69. A Karyological Study of Brassica. I. Naomasa SHIMOTOMAI. [Bot. Magaz. Tôkyô, **39**, 1925, 122-127].

The chromosome numbers of several species of *Brassica* are reported in this paper. The chromosomes were examined in the heterotypic and homoeotypic division of pollen-mother-cells. It is found that the haploid chromosome numbers of *B. oleracea* var. *capitata*, *B. oleracea* var. *acephara* and *B. oleracea* var. *gemmifera* are 9, and those of *B. campestris*, *B. campestris* var. *dentata*, *B. pekinensis*, *B. Rapa*, *B. chinensis* and *B. japonica* are 10, while those of *B. cernua*, *B. juncea* are 18.

Author.

70. Notes on the Histology of a Giant and an Ordinary Form of Plantago. Yosito SINOTÔ. [Bot. Mag. Tôkyô, **39**, 1925, 159-165, 2 figs.].

Plantago japonica, a littoral species growing wild in Japan, is conspicuously larger than the ordinary *P. major* var. *asiatica*. For example, according to the measurements of the author the spike length is in average 31.5, 49 and 93 cm in *P. major*, *P. major* var. *asiatica* and *P. japonica* respectively; and also leaf-blade, petiole length, the number of veins in each leaf are much larger in *P. japonica* than in the others. The microscopical examination has revealed the fact that the volume of nuclei is smaller in *P. japonica* than in *P. major asiatica* (volumes 1:1.7), while that of cells is nearly equal, so that the gigantism of *P. japonica* is due to the higher number of cells composing it. The author has also discovered the remarkable fact that the diploid number of chromosomes in *P. japonica* is 12 (root-tip), while in the two others the haploid and diploid number are 12 and 24 respectively.

71. Meiosis in Tropaeolum majus, L. Toranosuke SUGIURA. [Bot. Mag. Tôkyô **39**, 1926, 47-53, 1 pl.].

- 1) The number of chromosomes in the pollen-mother-cells of *Tropaeolum majus* is 14.
- 2) In the postsynaptic phase there are 4 paired chromosomes forming 4 rings

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telosyndetically and some bivalent chromosomes forming long rods, the other univalent ones forming shorter rods in irregular forms.

3) In the diakinesis both chromosomes, paired and unpaired, somewhat contract and are arranged in pairs.

4) The wall formation in the dividing pollen-mother-cells is centripetal and usually it begins at once when the second division is over and 4 spores are formed. But sometimes it begins in an earlier stage, even at the end of the first division, first dividing the cell horizontally, and after that the second wall being formed crosswise to the newly formed cell wall.

5) The pairing of the chromosomes in the somatic cells is also demonstrated in *Tropaeolum*.

6) In the cortical parenchyma of *Tropaeolum* there are found amitotic figures, often 3 or more nuclei being present in a cell. Author.

72. On the Meiotic Division of Pollen-Mother-Cells of Polygonum Savatieri, Nakai. Toranosuke SUGIURA. [Bot. Mag. Tôkyô, 39, 1925, 291-296, 1 pl.].

1) Nucleolar buds found on the achromatic thread disappear at the time of chromosome formation and seem to supply their substance for its formation.

2) In the postsynaptic stage there are two ring-, two dumb-bell-, and six rod-shaped bivalent chromosomes, each pair being united telosyndetically.

3) There is a true diakinetik stage. In this stage 5 paired granular gemini in almost equal size are seen, although they are variously shaped in the previous stages.

4) The haploid number of chromosomes is 10.

5) In the homoeotypic division two spindle axes are perpendicular, parallel, or inclined to each other.

6) The mode of formation of the partition-wall between the tetrad-cells is by the furrowing process and no trace of the cell plate is observed.

7) There is here also a coincidence between the telosyndesis and the furrowing process in the formation of the partition-wall of the tetrads.

8) There is a structure reminding us of a GOLGI apparatus in the tapetum cell of the present material, although it was fixed with FARMER'S fluid. Author.

73. Über die Keimungsfähigkeitsdauer der Sumpfreiskörner. (Japanisch). Iwao SUZUTA. [Sep. aus Landw. Mitteil. Formosa, 226, 1925, 6 S.].

Sobald nach der Ernte wurden die Reiskörner im Schrank mit CaCl_2 aufbewahrt. Es zeigte sich, dass nach zwei Jahren das Keimungsprozent bei einer Sippe noch 99.4 % und bei einer andern 93.4 % beträgt.

74. Über die Keimung der Papayasamen. (Japanisch). Iwao SUZUTA. [Sep. aus Landw. Mitteil. Formosa, 227, 1925, 7 S.].

Nach den an den Phillipinen Ins. ausgeführten MORADAS Versuchen ist das mehr oder minder direkte Sonnenlicht für die Keimung der Papayasamen unentbehrlich, wenn auch das ununterbrochene direkte Sonnenlicht das Keimungsprozent erniedrigt oder sogar die Keimung ganz verhindert. Der Verf. hat die Papayasamen in einem auf 35°C regulierten Thermostat gelegen, d. h. am ganz dunklen Orte und ihre Keimung studiert. Danach wenn nur destilliertes Wasser ihnen gegeben ist, konnte er gar keine Keimung beobachten, doch wenn eine 0,0005-0,01 Mol. Lösung von Natriumnitrit gegeben ist, sind sie bald zur Keimung angekommen. Der Verf. meint, dass bei der Keimung der Papayasamen er den dafür nötigen Lichtreiz durch denselben des Natriumsalzes ersetzen konnte.

75. Mitosen bei Sargassum. Masato TAHARA und Naomasa SHIMOTOMAI. [Se' Rpts. Tôhoku Imp. Univ. IV. Ser. 1, 1926, 189-192].

Beim ersten Teilungsschritt im Oogonium von *Sargassum nerve* treten 32 Chromosomen auf. Durch die darauf folgenden zweimaligen Mitosen entstehen zunächst acht Kerne. Unter diesen acht gehen aber inzwischen die sieben, nicht sechs, zugrunde. Der intakte, einzige Kern, der definitive Eikern, bleibt noch in der Peripherie des Oogoniums und führt dort eine mitotische Teilung aus. In der Telophase dieser Teilung weichen die zwei Tochterkerne auseinander und der eine bewegt sich nach dem Centrum des Oogoniums. Diese Teilung des definitiven Eikerns findet sich fast in demselben Momente der Degeneration der sieben abortiven Kerne statt. Darum scheint es oft, als ob bei dieser Alga die zwei unter den zuerst im Oogonium entstehenden acht Kernen an der Ausbildung des Keimes beteiligt wären. Autoren.

76. On a New Method of Computation of the Crossover Value from F_2 Zygotic Series. Yosinori TAKEZAKI. [Japan. Jour. Genetics, 3, 1925, 105-113].

When a heterozygote $AaBb$ produces the gametic series $\frac{p}{2}AB : \frac{1-p}{2}Ab : \frac{1-p}{2}aB : \frac{p}{2}ab$, where the crossover value is p and $1-p$ in repulsion and coupling respectively, the zygotic series is

$$\frac{2+p^2}{4}AB : \frac{1-p^2}{4}Ab : \frac{1-p^2}{4}aB : \frac{p^2}{4}ab,$$

then the correlation coefficient r of A and B is

$$r = \frac{\frac{2+p^2}{4} \times \frac{p^2}{4} - \left(\frac{1-p^2}{4}\right)^2}{\sqrt{\left(\frac{2+p^2}{4} + \frac{1-p^2}{4}\right)\left(\frac{1-p^2}{4} + \frac{p^2}{4}\right)}}$$

therefore $p = \frac{\sqrt{3r+1}}{2}$, so that the crossover value can be easily calculated from r . The author gives a table of the crossover values (either repulsion or coupling) corresponding to the r value from $-0,333$ to $0,999$, calculated by his method.

Further, he gives the formulae for calculating the probable errors of the crossover values and correlation coefficients r , together with a table for making their calculation easier.

77. On the Scientific Name of Lemon. (Japanese). Tyôzaburô TANAKA. [Bult. Sc. Fak. Terkult. Kjuŝu Imp. Univ. 1, 1925, 59-68].

Lemon is called by various scientific names. The author discusses what will be the correct scientific name for it, and concludes that *Citrus Limon* BURM. ist the only correct one.

78. On Canton Lemon, *Citrus limonica* Osbeck. (Japanese). Tyôzaburô TANAKA. [Bult. Sc. Fak. Terkult. Kjuŝu Imp. Univ. 1, 1925, 107-126, 1 pl., 2 figs.].

Canton lemon (*Citrus limonica* OSBECK) is one of the most important Chinese species of *Citrus*; it is exclusively produced in the Canton province, where there are several varieties slightly different from each other. In India and Algeria there are some closely allied plants, which are impossible to be considered as separate species. The author thinks that it is possible to cultivate the Canton lemon in warmer regions of Japan.

79. Further Data on Bud-variation in Citrus. Tyôzaburô TANAKA. [Japan. Jour. Genetics, 3, 1925, 131-143].

Some examples of bud-variation of Satsuma orange (*Citrus unshiu* Hort.) in various parts of Japan are described. The variation is distinguished by the difference in fruits, foliage, branches, etc., and especially by the early maturity and better economic value of fruits. The development of vegetative part of the bud-sport is rather worse than in the original plant, for the total growth seems to be stunted, giving it the general appearance of dwarfness. The author proposes the elimination of such undesirable character by means of grafting of bud-sports on certain stocks, which will lead to their better growth. Though the characters of bud variation are not simple, they may be due to the manifold action of a single recessive factor a . The author thinks that the latter was originated from the normal factor A by the process of allelomorphic transformation, i. e. $A \rightarrow a$. The reversion which is often observed may be the reverse process $a \rightarrow A$.

80. Untersuchungen über die Beziehungen zwischen den Pflanzen und ihren äusseren Lebensbedingungen auf quantitativem Wege. I. Einiges über Studien an *Oenothera biennis* und *Oe. odorata*. (Japanisch). Makoto TAKENOUCI und Riihiro KÔKETSU. [Bult. Sci. Fakult. Terkult. Kjusû Imp. Univ. 1, 1925, 149-168].

Die Verfasser suchten festzustellen, inwieweit die äusserlich wenig unterscheidbare Verschiedenheit der Bedingungen an verschiedenen Standorten einen Einfluss auf die Pflanzen ausüben kann. Einerseits wurde die Beschaffenheit der Versuchsmateriale *Oenothera biennis* und *Oe. odorata* studiert, welche teils auf einem sonnigen Strand und teils auf einem davon nur 225 m. entfernten ebensogut sonnigen Innenort wuchsen, während andererseits die Wasserbeziehung an beiden Standorten miteinander vergleichend studiert wurde.

Obwohl die sog. Wasserkapazität des Bodens an beiden Versuchsorten beinahe gleich war, so war die Wasserhaltungskraft des Bodens des Innenortes eine höhere. Dagegen war der Wassergehalt des Bodens *in situ*, welcher an einem höchst trockenen Tage bestimmt wurde, am Strande höher. Die äussere Gestalt der an beiden Orten befindlichen Pflanzen war sehr ähnlich. Aber durch zahlenmässige Darstellung des Veränderungsgrades an der Form und dem Bau der Rosettenblätter wurde festgestellt, dass es zwischen den Individuen an beiden Versuchsorten einige Unterscheidnugsmomente gab, welche wahrscheinlich auf eine Xerophytie der Pflanze am Innenort hinweisen.

Der Wasser- und Aschengehalt der Blätter, die Zellsaftkonzentration der Blattepidermiszellen, die Welkungserscheinung der Pflanzen und der Widerstand der Blattgewebe gegen Evaporation wurden nebeneinander studiert. Die Verfasser bestimmen weiter den Wassergehaltsrückstand im Boden an dem Punkt, wo die darin bewurzelten Pflanzen jetzt in einen bestimmten Zustand des Welkens eingetreten waren, um die Wasserhaltungskraft beider Bodenarten zu urteilen.

Aus solch einer Reihe der Versuche kam es so zu schliessen, dass der Strandort physiologisch weniger leicht trocknet, obwohl näher an der See gelegen, und die Pflanzen selbst an dem Innenort sowohl physiologisch als auch morphologisch mehr xerophytisch geworden sind, was alles erst durch die Studien auf dem quantitativen Wege anschaulich geworden ist.

Autoren.

81. Chromosome Numbers of Wild Barley. Shichiro TANJI. [Bot. Mag. Tôkyô 39, 1925, 55-57, with figs.].

The author has examined the root-tips of various races of Barley, incl. both wild and cultivated, and found that the diploid number of chromosomes is always 14.

82. Über die Absorptionsspektren der Pflanzenfarbstoffe der Flavonreihe II-III. Tomokichi TASAKI. [Acta Phytochem. **3**, 1925, 119-128, 1 Taf., und 129-137, 1 Tafel.].

83. Stinging Smut of the Barley and the Naked Barley in Japan. (Japanese). Heizi TASUGI and Wataru YAMADA. [Ann. Phytopathol. Soc. Japan **1**, 6, 31-41, 2 figs.]

A stinging smut was found, which is infecting not only the common barley, but also the naked one. The authors identify it with *Tilletia Panicis* BUBÁK. The results of macro- and microscopical studies are given.

84. Some Studies on a Japanese Apple Canker and its Causal Fungus, Valsa Mali MIYABE et YAMADA. Kogo TOGASHI. [Journ. Coll. Agric. Hokkaido Imp. Univ., Sapporo, **12** (1924), 267-324, 4 pls.].

A large number of apple trees in Hokkaido and the northern provinces of Japan are seriously damaged with a canker disease caused by *Valsa Mali* MIYABE et YAMADA.

The infected bark shows at first a swollen water-soaked appearance in early spring without any fluid drops. Later, the lesion dries up and becomes sunken. About a month after infection the black fruiting pustules cover the entire cankered area. When the weather is damp, from these pustules the pycnospores ooze out in yellow tendrils.

The pycnidia are quite variable in size and shape, or labyrinthform, having a single exit. The pycnospores are allantoid, colorless and measure $4-10 \times 0.8-1.7 \mu$. The asci are clavate-oblong or clavate-fusiform and measure $24-42 \times 5.5-15.0 \mu$. The ascospores are similar with the pycnospores in shape and measure $7-11 \times 1.4-2.1 \mu$.

The causal fungus is a wound parasite requiring old wounds or dead barks. Among 49 varieties of apple trees inoculated artificially, Stark Florence and Newton which have no economic importance, were not affected by the fungus. Under favorable conditions, *Valsa Mali* has the power to infect *Populus nigra* var. *italica*, *Salix sachalinensis*, *Prunus serrulata* var. *sachalinensis* and *P. yedoensis*, when they were inoculated with a piece of the hyphae on the wounds. All affected trees, however, recovered from the disease in the course of a year. Negative results were obtained with pycnospore inoculations on these trees. In the case of *Malus Zumi*, infection took place when it was inoculated either with the pycnospores or mycelium and the disease progressed as in apple trees.

The germination of the pycnospores and ascospores is preceded by an enormous swelling of the cells and both spores are often divided into two cells before the germination occurs. The most vigorous growth of mycelium and abundant production of pycnidia took place on culture media of apricot agar and sterilized apple twigs. Increased cane sugar or glucose resulted in a corresponding increase in mycelial growth. In the cases of peptone and asparagin, one per cent media are most suitable for the growth of the fungus. The combination of glucose and asparagin is most advisable for the purpose of pycnidial production. Concentrations below M/2000 of tannic acid show more luxuriant mycelial growth than without it, but concentrations stronger than M/1000 retarded it. The optimum temperature for growth of the fungus is 28° to 31° , the maximum about 37° to 38° , and the minimum somewhere between 5° to 10° . The pycnospores do not maintain their vitality after 15 minutes' exposure at 50° , as well as 3 hours' at 45° , the results somewhat varied on different media.

Author.

85. Über die Kontraktion und daraus verursachte Anomalie in der Wurzel von Cycas revoluta. Kiyohiko WATANABE. [Japan. Jour. Bot. **2**, 1925, 293-297, 11 Textfig.].

85. Studien über die Meeresalgen von der Insel Formosa. Yukio YAMADA. [Bot. Mag. Tôkyô **39**, 1925, 77-95, 5 Textabbild.; 239-254, 6 Textabbild.].

Die von dem Verf. auf der Nord- und Südküste Formosas und den Inseln Peskadoren gesammelten Algen sowie einigen des andern Ursprunges sind in diesen "Studien" dargelegt.

Die Chlorophyceen enthalten 5 Ulvaceen, 10 Valoniaceen, 7 Cladophoraceen, 2 Dasycladaceen, 1 Bryopsidacee, 3 Caulerpaceen und 7 Codiaceen, von denen die folgenden neu sind: *Dictyosphaeria bokotensis*, *Rhipidiphyllon nigrescens*, *Cladophora Montagnei* KÜTZING var. *radicans* var. nov., *Chlorodesmis formosana*.

Die Phaeophyceen enthalten 2 Ectocarpaceen, 1 Sphacelariacee, 6 Encoeliaceen, 12 Fucaceen, 9 Dictyotaceen, von denen die folgenden neu sind: *Turbinaria filamentosa*, *Zonaria coriacea*, *Padina minor*, *Dictyota dilatata*.

Alle neue Arten (auch eine neue Varietät) sind lateinisch beschrieben und illustriert.

87. Verbreitung von Azotobacter in den Kulturböden Japans, seine Arten und seine Beziehungen zu den Bodenreaktionen. (Japanisch. Unokiti YAMAGATA. [Aso und seine Mitarbeiter, Mitteilungen über die Untersuchungen betreffend den praktischen Gebrauch des von den Bakterien aufgenommenen freien Stickstoffes, Tôkyô **1**, 1925, 3-42, 3 Tafeln und 7 Textabbild.].

An den verschiedenen Gegenden von ganzen Japan wurde eine gewisse Menge von Kulturböden gesammelt und davon wurden auf Grunde verschiedener Experimente die folgenden Tatsache festgestellt.

Im ganzen gibt es drei Arten von *Azotobacter*, nämlich *A. chroococcum* BEIJ., *A. Beijerinckii* J. G. LIPMAN und *A. Vinelandii* J. G. LIPMAN, von denen alle im nördlichen Teilen Japans nur wenig vertreten sind und nach dem südlichen, d. h. wärmeren allmählich zunehmen. Die Menge des fixierten Stickstoffes beträgt im Mittel 6,28, 4,87, und 11,01 mg. pro 1 gr. Mannit (ASHBYS Mannit-Agar als Nährboden benutzt) für *A. chroococcum*, *Beijerinckii* bzw. *Vinelandii*. *A. chroococcum* und *Vinelandii* wurden in den Kulturböden über PH 7,3-7,8, und *A. Beijerinckii* in denselben unter PH 6,5-7,7 aufgefunden. Betreffend die PH-Werte sind das Optimum und ihre Grenze für die Vermehrung jeder Art wie folgt:

	Optimum	Grenz
<i>A. chroococcum</i>	7,6-8,3	5,8
<i>A. Beijerinckii</i>	6,8-7,4	5,8
<i>A. Vinelandii</i>	7,6-8,3	5,9

88. Die Flechten Japans. (Japanisch). Atsushi YASUDA. [Sendai, 1925, 118 S. Text und 24 Lichtdrucktafeln].

Nach den hintergelassenen Schriften des verstorbenen Verfassers von Y. ASAHINA bearbeitet. 191 japanische Flechten sind einzeln ziemlich ausführlich beschrieben und illustriert.

Abstracts Nos. 89—129

(Referring to the principal papers on Botany and allied subjects which have appeared in Japan mostly from the end 1925 to February 1926)

89. Studies on the Apple Rust Caused by *Gymnosporangium Yamadae* Miyabe. Teikichi FUKUSHI. (Jour. Coll. Agric., Hokkaido Imp. Univ. **15**, 1925, 269-307, 4 pls.)

The author has made the inoculation experiments of the apple rust fungus, *Gymnosporangium Yamadae* on 50 apple varieties. The varieties Fameuse and McIntosh Red (which is known to be a seedling plant of Fameuse) were found to be most resistant, where only minute spermogonia but no aecidia are produced, and the mycelial growth is restricted to the leaf tissue under the spermogonia. In susceptible varieties, on the contrary, the affected area undergoes the hyperplasy, owing to an excessive enlargement and multiplication of the spongy parenchyma cells; the degenerating chloroplasts are very conspicuous.

The temperature for the germination of teleutospores is maximum 30°, minimum 7°, optimum 16°-22°C. The aecidiospores can scarcely be induced to germinate during the season in which they are produced; they were found to retain their germination power during 177 or 212 days.

The gall produced on *Juniperus chinensis* which originates as an abnormal growth of the stem tissue at the base of the leaf is surrounded by several cork-layers. The greater part of the gall is occupied by the parenchyma, which consists of the medullary ray cells and the bast parenchyma cells which have abnormally grown up and divided. The vascular bundle is derived chiefly from that of the stem. The mycelium is found throughout the gall tissue except the cork-layers.

90. Genetic Studies of Leaf-character in Morning Glories IV. On the Relation between "Tonboba" and White Flower. (Japanese). Tokio HAGIWARA. (Bot. Mag. Tôkyô **40**, 1926, 21-29).

A partial linkage with the gametic ratio 5.6:1 exists between the factor *c* for white flowers and *k* for "Tonboba" leaf, where the crossover percentage may vary from 13.3 to 33.3. The factor transformations, $K \rightarrow k$, $C \rightarrow c$, as well as their reverse processes take place to a certain extent, *K* and *C* being the allelomorphs for normal leaf and chromogen respectively.

91. Revisio Graminum Japoniæ VII. Masaji HONDA. (Bot. Mag. Tôkyô **39**, 1925, 33-43).

Chamaeraphis spinescens POIRET is new as a Formosan plant, and its variety *depauperata* J. D. HOOKER was found in Japan proper.

Zizania latifolia TURCZANINOW. This Asiatic species differs by having perennial rhizoms and stolons from the American species *Z. palustris* LINNÉ and *Z. aquatica* LINNÉ which are both annual.

MIEG's genus *Homalocenchrus* being adopted instead of *Leersia* SWARTZ on account of the strict priority, the names *Homalocenchrus oryzoides* POLLICH, *H. oryzoides* var. *japonicus* HONDA, *H. hexandrus* O. KUNTZE and *H. japonicus* HONDA are acknowledged anew.

The scientific name *Euchlaena luxurians* DURIEU et ASCHERSON is to be replaced by *E. mexicana* SCHRADER.

Saccharum spontaneum var. *Roxburghii* HONDA is a new variety which has a tall culm and a ciliate ligule; its type is found in India and Formosa.

Imperata cylindrica BEAUVOIS and its variety *Koenigii* HONDA are adoptable in place of *I. arundinacea* CYRILLO and *I. arundinacea* var. *Koenigii* BENTHAM.

Imperata exaltata var. *genuina* HACKEL and *Paspalum conjugatum* BERGIUS are reported as new grasses in Formosa.

Syntherisma Sasakii HONDA and *Pollinia glaberrima* HONDA are both new species found in Formosa.

Pollinia monantha NEES var. *formosana* HACKEL is to be considered as a variety of *Pollinia ciliata* TRINIUS.

Pollinia monantha NEES var. *mentenensis* HONDA is a new variety found in Formosa.
Author.

92. Revisio Graminum Japoniæ VIII. Masaji HONDA. (Bot. Mag. Tôkyô 39, 1925, 267-279).

In this paper the following grasses are reported.

Eccoilopus formosanus var. *tohænsis* HONDA nom. nov. (*Spodiopogon tohænsis* HAYATA or *Eccoilopus tohænsis* A. CAMUS).

Spodiopogon depauperatus var. *purpurascens* HONDA var. nov.

Spodiopogon Kawakamii var. *sativus* HONDA var. nov.

Spodiopogon tainanensis var. *Takeoi* HONDA nom. nov. (*Spodiopogon Takeoi* HAYATA).

Spodiopogon Hayatai HONDA sp. nov.

Spodiopogon gracilis HONDA sp. nov.

Pogonatherum crinitum TRINIUS. (*Pogonatherum saccharoideum* BEAUVOIS).

Manisuris exaltata KUNTZE (*Rottbællia exaltata* of many authors).

var. *appendiculata* HONDA nom. nov. (*Rottbællia exaltata* var. *appendiculata* HACKEL).

Manisuris compressa, KUNTZE (*Rottbællia compressa* of many authors).

Manisuris fasciculata, HITCHCOCK (*Rottbællia compressa* var. *fasciculata* and var. *japonica* HACKEL).

Manisuris latifolia, KUNTZE (*Rottbællia latifolia* STEUDEL).

var. *foliata* HONDA nom. nov. (*Rottbællia foliata* STEUDEL).

Rytillia granularis SKEELS (*Manisuris granularis* of many authors).

Arthraxon pauciflorus HONDA sp. nov.

var. *muticus* HONDA var. nov.

Arthraxon hispidus MAKINO.

var. *cryptatherus* HONDA nom. nov. (*Arthraxon ciliaris* subsp. *Langsdorffii* var. *cryptatherus* HACKEL).

var. *ceptrasiaticus* HONDA nom. nov. (*A. ciliaris* subsp. *Langsdorffii* var. *centrasiaticus* HACKEL.)

Andropogon integer HONDA sp. nov.

Author.

93. Sakugorô Hirase (1856-1925). Seiitirô IKENO. (Bot. Mag. Tôkyô 39, 1925, 96-98, 1 image).

L'article consacré à la description de la vie de feu S. HIRASE, bien connu par sa découverte des anthérozoïdes chez le *Ginkgo biloba*.
Auteur.

94. Beobachtungen über die Chloroplastenteilung von *Hydrilla verticillata*
Presl. Kogane KIYOHARA. (Bot. Mag. Tōkyō **40**, 1926, 1-6, 9 Abbild).

Der Verf. hat an lebenden Blättern von *Hydrilla verticillata* die Vermehrung der Chloroplasten genau verfolgen können. Danach nachdem die zuerst rundlichen Chloroplasten ungefähr 3μ Grösse erreicht hatten, nehmen sie die ellipsenförmige Gestalt an, dann erscheint eine unbedeutende Furche an ihrem Querdurchmesser, welche allmählich tiefer wird, sodass die Chloroplasten hantelförmig werden. Nach einiger Zeit teilen sie sich je zu zwei Teilkörnern. Somit ist der Vermehrungsmodus der Chloroplasten, welcher bereits bei den Kryptogamen festgestellt worden ist, auch bei den Phanerogamen sicher nachgewiesen. Die Vermehrung de novo wird aber keineswegs von dem Verf. in Abrede gestellt. Autor.

95. Ueber den Aussenbedingungen auf das Blütenöffnen der Reispflanzen.
II. Einfluss des Lichtes. (Japanisch). Yakiti KOBAYASI. (Jour. Sc. Agric. Soc. Japan No. **279**, 1926, 59-72, 4 Abbild).

Um die Tatsache kennen zu lernen, ob das Licht auf das Blütenöffnen irgend einen Einfluss ausüben kann, hat der Verf. diesen Vorgang bei dem vollen Sonnenlichte und der Dunkelheit vergleichend untersucht. Danach hat er die Schlüsse ziehen können, dass bei der Dunkelheit das Blütenöffnen stark verzögert wird und auch die Zahl der öffnenden Blüten nicht unerheblich abnimmt. Das Anthereöffnen, die Bestäubung und das Fruchtingsprozent wurden dabei gar nicht beeinträchtigt. Nach den Verf.'s Beobachtungen unter dem monochromatischen Lichte beschleunigt das orangefarbige das Blütenöffnen meistens, dann folgt das gelbe.

Das elektrische Licht beschleunigt auch diesen Vorgang erheblich. Autor.

96. On the Structure of the Anaphasic Chromosomes in the Somatic Mitosis in *Vicia Faba*, with Special Reference to the So-called Longitudinal Split of Chromosomes in the Telophase. Yoshinari KUWADA. (Mem. Coll. Sci., Kyoto Imp. Univ. Ser. B., **2**, 1926, 1-13, 1 pl.)

The spiral structure of chromosomes as observed first by BARANETZKY in *Tradescantia* was found in anaphasic chromosomes in root-tips of *Vicia Faba* fixed with BENDA's solution. In the early metaphase the chromosomes are of a string-of-pearls structure. As a consequence of shortening of the chromosomes as a whole, individual pearls or chromomeres come in contact with each other so as to make smooth strands which, by further shortening of the chromosomes, assume first a zig-zag, later a spiral appearance. The author is of the opinion that this spiral part of the chromosomes, or chromonema, is the essential part of the chromosomes that retains its individuality throughout the life history of the chromosomes, and that, if the theory of the linear arrangement of genes in the chromosome is accepted, the spiral structure of the anaphasic chromosomes is not in accordance with the view, maintained by some authors, of an anaphasic or telophasic split of chromosomes. Author.

97. Further Studies on the Staining Reaction of the Spermatozooids and Egg Cytoplasm in *Cycas revoluta*. Yoshinari KUWADA. (Bot. Mag. Tōkyō **40**, 1926, 198-201).

With the same methods of procedure as mentioned in his previous paper the author repeated tests with the spermatozooids and egg cytoplasm of *Cycas revoluta*, special attention being paid to fertilization. The results show that the reactions of the egg cytoplasm

are contrary to those of the spermatozoids before fertilization, but tend to be the same as the latter after fertilization. Sixteen microphotographs are given to illustrate this change of the reactions in these two different phases. Author.

(S. Japan. Jour. Bot. 3, (12), Abstract No. 37.—Editor).

98. On the Structure of the Chromosomes in *Tradescantia virginica*. (Preliminary Note). Yoshinari KUWADA, and Tadazo SUGIMOTO. (Bot. Mag. Tôkyô 40, 1926, 19-20, 2 figs.).

In metaphasic chromosomes in the heterotype division of fresh pollen mother cells of *Tradescantia virginica* stained with neutral violet extra the authors found the spiral structure observed by BARANETZKY. While the spiral structure of chromosomes found in the somatic mitosis in *Vicia Faba* is fully in accord with the principle of the longitudinal splitting which is supposed to occur in the prophase, what appears to be the same structure, seen in the heterotype chromosomes in *Tradescantia*, seems to stand in disharmony with the principle, because, while in *Tradescantia* the longitudinal splitting of chromosomes for the homotype division has been clearly observed by STRASBURGER in the late anaphase of the heterotype division, the spiral in the metaphasic chromosomes in the heterotype division appears to be single. The behaviour of the spiral in the course of the division has not been thoroughly studied yet. Y. K.

99. A Study of the Mycorrhiza of *Abies firma*, S. et. Z., with Special Reference to its Mycorrhizal Fungus, *Cantharellus floccosus*, Schw. Koki MASUI. (Mem. Coll. Sc., Kyoto Imp. Univ. Ser. B, 2, 1926, 15-84, 4 pls. and 36 figs.).

Cantharellus floccosus was found to cause the ectotrophic mycorrhiza not only in *Abies firma*, but also in *A. Mayriana*, though the author's present investigations are chiefly concerned with the mycorrhiza of the former species.

The mode of origin of the fruit-body is various: it develops directly on the infected root, at the termination of the mycelial strands derived from the infected roots, on a mycelial network formed by the hyphae projected from numerous small mycorrhizas, or also as a side branch of an old fruit-body. Not only does the fungus form a more or less thick mantle around the root, but its hyphae may attain the cortex, the pericycle, and even the central cylinder, and also they may produce the intracellular hyphae.

The infection is caused, not only by the mycelial filaments derived directly from the spores, but also by filaments and strands given off from the preexisting mycorrhizas.

The comparison of infected and uninfected roots by the microchemical methods has revealed among others the facts that the quantity of starch preserved in the pericycle diminishes by the infection of the fungus, and also that of nitrates and nitrites in the cortex is much smaller in the former than in the latter. These facts, together with the author's observation that the rate of growth of the main lateral roots diminishes by the fungous infection, etc., have led him to the conclusion that the mycorrhiza under discussion is not to be considered as a symbiosis, but as a case of parasitism.

The size of the fruit-body is generally proportional to that of infected roots. It, as well as mycelial masses of the present fungus do not occur in damp soil, nor do these occur under or near young trees, for the existence of young roots in the superficial layer of the soil is an important factor for their production and young trees are generally deep-rooted.

The author describes the mode of development of the fruit-body.

There are four different forms of mycorrhiza caused by different fungi. Of these

the form B, an ectotrophic one that produces basidia-like projections from which spore-like bodies are discharged, is especially to be mentioned as new to the science. Whether these latter are capable of germination and may perform the new infection, is yet undetermined.

Author.

100. On the Renewed Growth of the Mycorrhizal Root. Koki MASUI. (Mem. Coll. Sc., Kyoto Imp. Univ. Ser. B, **2**, 1926, 85-92, 1 pl. and 4 figs.).

Whether the mycorrhiza may grow in length after a complete fungous mantle has been formed, is a question, which MAC DOUGAL for instance answers negatively. On the contrary, on account of the observations on the mycorrhizas of *Abies firma*, *A. Mayriana*, *Alnus japonica* and *Pinus densiflora* the author was led to the positive conclusion. According to him the mantle which has completely covered the rootlet is split in various directions by the pressure exerted by its growth, provided the latter possesses the capacity of further growth; it peeps out then from the fissure of the mantle, and makes further length growth free from it. The new root-tip thus formed is however sooner or later covered by the fungous mantle which arises from the margin of the fissure.

Author.

101. On the Relationship between Melampsora on Salix Pierotii Miq. and Caecoma on Chelidonium majus L. and Corydalis incisa Pers. Takashi MATSUMOTO. (Bot. Mag. Tôkyô **40**, 1926, 43-47, 2 figs.)

The inoculation of *Salix Pierotii* with the caecomaspores from *Chelidonium majus* and the return inoculation of the latter with the teleutospores from the former, and also the inoculation of *Salix Pierotii* with the caecomaspores from *Corydalis incisa* and the return inoculation of the latter with the teleutospores of the former were performed. In both cases the author has got positive results.

The aecidial stage of the fungus under discussion is very closely related to the corresponding stage of *Melampsora Magnusiana* WAGNER on *Populus* sp. and to that of *M. Klebahnii* BUBÁK on *Corydalis cava*. As the present fungus is however different from these *Melampsora* species in several respects, the author considers it to be a new species, *M. Chelidonii-Pierotii*, and gives its diagnosis.

102. Bericht über die neuerdings gesetzlich geschützten botanischen Naturdenkmäler. Manabu MIYOSHI. (Bot. Mag. Tôkyô **39**, 1925, 235-238).

Fünf neuerdings durch die Regierung gesetzlich geschützte botanische Naturdenkmäler sind hervorgehoben. Eine neue, durch den eigentümlichen Fruchtbau von nahe verwandten *Torreya nucifera* unterscheidbare Art, *T. nuda*, wird beschrieben: dabei besitzt die Frucht keine innere holzige Schale, sodass der Same direkt von den äusseren fleischigen Schale umschlossen ist.

103. Filices Adansonianæ. Takenoshin NAKAI. (Bot. Mag. Tôkyô **40**, 1926, 59-68).

When the author was in Paris in 1923, the long hidden specimens of M. ADANSON which made the materials of his 'Familles des Plantes' became the possession of the Natural History Museum of Paris. Availing himself of the opportunity he took up the Filices, and determined all the species and varieties. The results are as follows.

- I. *Thelypteris* (ADANSON p. 20) comprises 1 *Alsophila*, 1 *Antrophyllum*, 2 *Dryopteris*, 1 *Gymnocarpium*, 2 *Pteridium*, 7 *Pteris*, and 1 *Gleichenia*.

- II. *Adiantum* (ADANSON p. 20) comprises 10 *Adiantum*, 1 *Davallia*, 1 *Dænstaedtia*, 1 *Lindsaya*, 1 *Hypophyllum*, 1 *Trichomanes*, and 1 *Lygodium*.
 - III. *Scolopendrium* (ADANSON p. 20) comprises 1 *Asplenium*, 4 *Phyllitis*, 1 *Stenochlaena*, and 1 *Marattia*. The later botanists, too, used *Scolopendrium* in broader sense. However, the author uses *Phyllitis* instead of *Scolopendrium*, although the latter was recommended by the Brussels Congress.
 - IV. *Filix* (ADANSON p. 20) comprises 4 *Alsophila*, 2 *Asplenium*, 1 *Athyrium*, 3 *Cystopteris*, 1 *Dænstaedtia*, 6 *Dryopteris*, 1 *Goniopteris*, 1 *Leptogramme*, 1 *Matteuccia*, 1 *Polystichum*, and 1 *Pteridium*.
 - V. *Ceterac* (ADANSON p. 20) comprises 1 *Ceterach*, 6 *Asplenium*, and 1 *Stenochlaena*; so the generic name *Ceterac* (*Ceterach*) is not similar to the *Ceterach* in the present time.
 - VI. *Dryopteris* (ADANSON p. 20) comprises 5 *Polystichum*, 8 *Dryopteris*, 1 *Athyrium*, 1 *Asplenium*, 1 *Lepiogramme*, 1 *Cystopteris*, 1 *Gymnocarpium*, and 1 *Nephrolepis*.
- The author has also studied the type-specimens of MICHAUX and concluded that *Dryopteris* of ADANSON is better than *Nephrodium* of MICHAUX. In addition, he has made criticisms on *Thelypteris* of SCHMIDEL, *Polystichum* of ROTH, *Hypopeltis* of MICHAUX, *Aspidium* of SWARTZ, *Rumohra* of RADDIUS, and *Bathmium* of LINK, and suggested that *Bathmium* is better than *Aspidium*.
- VII. *Polypodium* (ADANSON p. 20) includes 2 *Gleichenia*, 1 *Goniopteris*, 1 *Meniscium*, and 9 *Polypodium*.
 - VIII. *Hemionitis* (ADANSON p. 20) represents *Diplazium*.
 - IX. *Blechnum* (ADANSON p. 20) includes 2 species of the real *Blechnum*.
 - X. *Osmunda* (ADANSON p. 21) comprises 1 *Ficus*, 1 *Acrostichum*, 1 *Asplenium*, 1 *Blechnum*, 1 *Cryptogramme*, 1 *Diplazium*, 1 *Pellaea*, 1 *Polypodium*, 1 *Osmunda*, and 1 *Botrychium*.
 - XI. *Angiopteris* (ADANSON p. 21) represents *Onoclea*, L.
 - XII. *Ophioglossum* (ADANSON p. 21) represents the real *Ophioglossum*.
 - XIII. *Palma-Filix* (ADANSON p. 21) represents *Aspidium*.
 - XIV. *Filularia* (ADANSON p. 21) represents the real *Pilularia*.
 - XV. *Lemma* (ADANSON p. 21) represents *Marsilea*.

The author wishes to conclude that the genera of Filices published by ADANSON would not be of much use for taxonomy, except *Dryopteris* which might be used if backed by Dr. CHRISTENSEN's Index Filicum. Author.

104. Weitere Untersuchungen über die Lebensdauer der Weidensamen. Yôzô NAKAJIMA. (Sc. Rpts. Tôhoku Imp. Univ. IV. Ser. (Biol.), 1, 1926, 261-275).

Bekanntlich ist die Keimfähigkeitsdauer von Weidensamen verhältnismässig kurz, so z. B. beträgt die bisher beobachtete längste nur etwa 48 oder 85 Tage nach WOLOSZCZAK bzw. WIESNER. Früher ist es jedoch dem Verf. gelungen, mittelst einer gewissen Aufbewahrungsmethode, sogar nach 320 Tagen die 2% gute Keimung zu bekommen (vgl. Jap. Jour. Bot. 1, (12), Abstrakt Nr. 29). Die vorliegenden an *Salix Pierotii* und *japonica* ausgeführten Untersuchungen bilden die Fortsetzung der obengenannten früheren aus. Unter gewöhnlichen Umständen verlieren die Samen dieser zwei Weidenarten schon nach einer Woche ihre Keimfähigkeit. Wenn sie aber gleich nach der Ernte in der Luft des Eisschranks gehalten, oder besser, wenn die Kätzchen direkt auf das Eis gelegt werden, dann wird ihre Keimfähigkeit stark verlängert. Noch bedeutendere Verlängerung konnte der Verf. erzielen, wenn die Kätzchen zuerst eine Woche auf Eis gelegt und die daraus bekommenen Samen über Schwefelsäure mit gleichem Volumen Wassers gemischt oder Kalziumchlorid (Kalziumchlorid 100 g + Wasser 25 cc.) gehalten wurden.

Wenn man die Samen von *S. Pierotii* im Eisschrank in einem verschlossenen Glasgefäße über verdünnter Schwefelsäure aufbewahrt und für die Durchlüftung besorgt, indem man zeitweise das Gefäß öffnet, kann die Keimfähigkeit der Samen auffallend verlängert werden, so z. B. konnte der Verf. in einem Falle sogar nach 360 Tagen 53% gute Keimung feststellen.

Autor.

105. Studies on the Helminthosporium-diseases of Maize. (Japanese). Yosikazu NISIKADO and Chuichi MIYAKE. (Agric. Studies **8**, 1926, 56 pp., 2 pls.)

The authors have made some investigations on the two diseases of maize, Maize Blight due to *Helminthosporium turcicum* PASS. and the Spot Disease due to *M. Maydis* NISIKADO et MIYAKE.

The first of the two above mentioned diseases is widely found throughout the world, while the second seems to be of much more restricted distribution.

The authors point out the difference of the two causal fungi in respect to the form and size of affected areas of the hosts, as well as those of the conidia.

The growth of *H. Maydis* is more sensible to the influence of the temperature than that of *H. turcicum*: for example, though no perceptible difference is observed in the growth of the latter at the temperature of 23° and 30°C, *H. Maydis* grows much more rapidly at 30° than at 23°. The conidia-formation goes very well at 23°; beyond 30° no conidia of normal shape are formed. At 20°-30° conidia of *H. turcicum* produce the germ-tube at their extremity. Soon after the appressorium is formed at the apex of the tube, and from the former a slender filament is produced, which penetrates into the host tissue, chiefly not through stomata. The germination of *H. Maydis* is similar to that of *H. turcicum*, though the germ-tube is more slender and grows much more rapidly. The inoculation experiments of *H. turcicum* have given 56% positive results, while those of *H. Maydis* 100%. The growth of both fungi takes place between pH 2.0-2.6 and 10.9 and best at 4.9-9.1.

106. Ueber die Chromosomen von Rumex scutatus. Koi NODA. (Japan. Jour. Bot. **3**, 1926, 21-24, 6 Textabbild.)

107. On the Structure of Alsophila Bongardiana Mett. (Japanese). Yudzuru OGURA. (Bot. Mag. Tōkyō **40**, 1926, 69-90, 9 figs.)

Alsophila Bongardiana has a tall stem with a number of prominent leaf-scars on its surface. The stem is anatomically characterized by the occurrence of numerous medullary and some cortical bundles. The former, each of which takes its origin in the pith, constitute during their upward course a complex network; finally, they go to leaf-gaps, and fuse with the leaf-traces belonging to the superior series. In each leaf-gap there are a pair of cortical bundles, which originate in the cortex; in their upward course through the latter they pass on to and fuse with the stelar margins, from where they are separated as the leaf-traces situated at the lateral corners of the superior strands.

The structure of the stele as well as the course of medullary bundles belong to that stelar type which the author calls "Cyathean Dictyostele" (s. Japan. Jour. Bot. **3**, 1926, (19), Abstract No. 58). But this species is distinguished from this type by the presence of cortical bundles. Since the latter fact may be taken for a characteristic of the present species, the author has proposed a new name "*Alsophilan Dictyostele*" for that type.

Author.

108. On the Structure of the Ancient, but still Viable Fruits of Indian Lotus, with Special Reference to their Prolonged Dormancy. Ichiro OHGA. (Japan Jour. Bot. **3**, 1926, 1-20, 1 pl. and 3 textfigs.).

109. Species Novae Polygonacearum Formosae. Kiichi OHKI. (Bot. Mag. Tôkyô **39**, 1925, 259-264).

The following 9 new species created by the author are described. *Polygonum bioritsuense*, *P. buisanense*, *P. dolichopedum*, *P. giranense*, *P. kawakamii*, *P. kotoshoense*, *P. omerostromum*, *P. pseudo-japonicum*, *P. pseudo-nodosum*. Author.

110. On the Determination of the Japanese Species of Abies, based on the Anatomical Characters of the Leaves. (Japanese). Kiichi OHKI. [Bot. Mag. Tôkyô **39**, 1925. (124)-(129)].

The classification of the Japanese species of *Abies* is made according to the anatomical characteristics of their leaves. The criteria for the determination of the species are as follows:

1. The presence or absence of the bast-fibers in the mesophyll;
2. The forms of the mechanical tissue under the epidermis;
3. The position of the resin-ducts in the mesophyll. Author.

111. Polygonaceae of the Island Iki. Kiichi OHKI. (Bot. Mag. Tôkyô **40**, 1926, 48-58).

An enumeration of a certain number of wild and cultivated plants found in the Island Iki in Northern Kyûsyû. It contains some new combinations.

112. On the Culture of Gracilaria confervoides. Kintarô OKAMURA. (Jour. Imp. Fish. Inst. **21**, 1925, 10).

Gracilaria confervoides is used as a material of agar, together with several species of *Gelidium* and allies; also as a paste for sticking papers. In Tokyo Bay its tetraspores ripen from May to August and cystocarps in summer. The carpospores germinate soon after the setting free of spores from cystocarp and the young plantlets are seen from July to the middle of September, the maximum period being August. At the end of October many grow into the length of 6-7 mm. The plant may be easily cultivated on a large scale by scattering over the sea-bed several substances such as shells, stones, bricks, etc. as the substratum on which the alga grows. Its growing zone measures about one meter in height in the Tokyo Bay, where the height of the spring tide measures 1.8 meter. Author.

113. Icones of Japanese Algae. Kintarô OKAMURA. Vol. V, No. 3-6, 1925, 20 pls. and 88 pp. text.

The following species and varieties are contained in these numbers:

No. 3: *Cystophyllum hakodatense*, YENDO, *Sargassum Kjellmanianum*, YENDO, *Sargassum hemiphyllum*, AG., *Sargassum micracanthum*, (KG.) YENDO, *Sargassum sagamianum*, YENDO.

No. 4: *Sargassum piluliferum*, AG., var. *pinnatifolium*, YENDO, *Sargassum patens*, AG., var. *Schizophylla*, YENDO, *Sargassum pinnatifidum*, HARV.

No. 5: *Laminaria japonica*, ARESCH., *Laminaria cichorioides*, MIYABE, *Kjellmanniella gyrate*, (KJELLM.) MIYABE, *Kjellmanniella crassifolia*, MIYABE, *Agarum Turneri*, POST. et RUPR.

No. 6: *Costaria Turneri*, GREV., *Arthrohamnus bifidus* (GM.) RUPR., *A. kurlensis* RUPR., *Thalassiphyllum clathrus* (GM.) P. et R., *Sargassum giganteifolium*, YAMADA sp. nov.

Author.

114. On *Laminaria angustata* Kjellm. and *L. longissima* Miyabe. Kintarô OKAMURA and Saburô UEDA. (Jour. Fish. Inst. **21**, 1925, 20-25, 1 pl.)

Laminaria longissima, a new species established by MIYABE in 1905, is distinguished from *L. angustata* KJELLM. chiefly by the mode of distribution of sori and that of the arrangement of mucilaginous ducts. According to this author, in *L. longissima* sori cover the upper portion of lamina on both surfaces, leaving simply the fascia sterile, while in *L. angustata* they cover the upper portion of lamina on the upper surface only. Again, in *L. longissima* the lamina is provided with an unbroken network of mucilaginous ducts, while in *L. angustata* it is broken up into many small pieces. As according to MIYABE *L. longissima* and *angustata* are found extending along the coast from Nemuro to Kusiro and that from Kusiro to Muroran respectively, one of the writers (UEDA) has collected the two so-called species from the two localities just mentioned, and made certain observations on them.

1. Though according to MIYABE no sorus seems to occur on the lower surface of *L. angustata* this is not really the case. On the contrary, the writers could observe in *L. angustata* such generally on the lower surface, but also rarely on the upper. In *L. longissima* the reverse is the case, for sori occur generally on the upper surface, and rarely on the lower.

2. According to MIYABE the network of mucilaginous ducts is complete and unbroken in *L. longissima* only, but the writers have observed such in *L. angustata* also. It is true that there are some irregularities in the network of the latter, but such are not wholly lacking in the other, as MIYABE himself says.

On the basis of the observations briefly mentioned in the above lines the writers came to the conclusion that between the two forms there are no essential differences, and they are to be considered to belong to one and the same species. Authors.

115. On the Harmful Action of Deep Fog on *Porphyra tenera* Kjellm. Kintarô OKAMURA, Saburô UEDA and Yutaka MIYAKE. (Journ. Imp. Fisher. Inst., **21**, 1926, 67-68, 4 figs.).

It has long been known among those who cultivate "Asakusanori" (*Porphyra tenera* KJELLM.) in Tokyo Bay, that the alga at once dies out after the formation of dense fog over *Porphyra*-fields at the time when "Hibi", i. e. the twigs on which the fronds grow, are exposed above the sea water at low tide. Though there are many other *Porphyra*-fields in this country, this phenomenon was hitherto limited to the fields situated near the City of Tokyo, where, it may be remarked, chimneys of various factories are very abundant. (The City of Osaka ranks next to Tokyo in the number of factories, but there is no *Porphyra*-field.) On the basis of the latter fact, one of the authors (OKAMURA) has maintained the opinion that the cause of the damage of dense fog is very probably due to the action of smoke escaping from chimneys which contains sulphurous acid gas abundantly.

As the results of experimental study to determine the cause of the damage the authors were led to the following conclusion.

The circumstances of environment which will cause dense fog, such as sudden change of temperature (of course within a certain limit) as well as vapour or water-drops them-

selves have no harmful influence, only the fog, or strictly speaking, the aqueous vapour condensed around the soot as the nucleus, is dangerous. This fog is harmful, because it contains small particles of incompletely burnt carbon, that is soot as the nucleus which absorbs sulphurous acid gas, together with harmless gases as watery vapour, carbon monoxide and dioxide. The carbon particles in soot absorb sulphurous acid gas as much as 7/10 time as their own volume. The sulphurous acid gas thus absorbed is maintained as long as four days, during which being gradually dispersed, it is finally reduced to less than 1/100 of the volume of carbon particles. The latter retaining sulphurous acid gas even less than 1/100 their own volume make damage on *Porphyra*, since the cells of the latter acted by such particles die in 15-30 minutes. When the air contains sulphurous acid gas of 1/10000 its volume, it kills the alga, though when more dilute, it is harmless.

Authors.

116. Kopulationserscheinungen bei der Sporenkeimung der Saccharomycesarten. (Japanisch). Kinsi SUMINOE. (Jour. Sc. Agric. Soc. Japan, No. 280 1926, 117-124, 2 Abbild.)

1. Aus den mittels der Kopulation ausgebildeten Sporen von *Saccharomyces* hat der Verf. die Reinkulturen bekommen. Die vergleichende Beobachtung derselben mit den aus gewöhnlichen Konidien entstandenen Reinkulturen hat keinen besonderen Unterschied der Kopulationshäufigkeit zwischen beiden erkennen lassen.

2. Der Verf. konnte nicht selten die Kopulation von drei Konidien miteinander feststellen, so z. B. je einmal pro 70 Fällen.

3. Die Gattung *Saccharomyces* HANSENS ist bekanntlich dadurch ausgezeichnet, dass erst nach der Kopulation von zwei Askosporen ein Keimschlauch entsteht. An den Hefen des japanischen Weines, welche zur Gattung *Saccharomyces* gehören, sowie Sakés, konnte der Verf. nicht selten den genau gleichen Vorgang beobachten, was die Grenze zwischen *Saccharomyces* und *Saccharomyces* verwischen könnte.

4. Nach den Verf.'s Beobachtungen über eine *Saccharomyces*art des japanischen Weines ist die Kopulationshäufigkeit viel grösser bei guter als bei schlechter Ernährung, welche entweder gerade zur Zeit der Kultur stattfindet oder vor der Sporenbildung stattgefunden hatte.

5. Der Verf. hat an einer Gruppe von keimenden Konidien die Zahl von den kopulierenden von Stunde zu Stunde ausgezählt, woraus er die grosse stündliche Schwankung der Kopulationshäufigkeit konstatiert hat. Doch nach den Verf.'s Beobachtungen kann man es als allgemeines Regel betrachten, dass die zum allerletzten Beobachtungszeitintervalle keimenden Individuen am seltensten kopulieren, ja sogar hat er bei den sehr spät keimenden gar keine Kopulationsfähigkeit feststellen können. Autor.

117. Studien über die Keimung der Sumpfreiskörner. (Japanisch). Iwao SUZUTA. (Mitteil. landw. Abteil. Versuchsanstalt Formosas, 29, 1926, 48 S.)

Der Verf. hat die enthülsten und die nicht enthülsten Sumpfreiskörner den Temperaturen von 30°-100°C während der Dauer von 1-5 Tagen ausgesetzt, und dann ihre Keimungsfähigkeit beobachtet. Danach kann man keine bedeutende Abnahme des Keimungsvermögens bis zur 80° beobachten. Erst beim 90° scheint eine nicht umkehrbare Koagulation des Protoplasmas einzutreten.

Die schnelle Keimung der Samen kann erst nach einer mehr oder minder grossen Nachreifungsperiode erfolgen. Die letztere kann man entweder durch ihre Lagerung unter direktes Sonnenlicht oder durch künstliche Heizung verkürzen. Durch den Gebrauch des Wasserstoffsuperoxyds kann diese Periode auffallend verkürzt werden.

Am Ende der Abhandlung weist der Verf. auf die Unterschiede verschiedener Keimungserscheinungen zwischen den Reissrassen von Formosa und eigentlichen Japan hin.

118. On Certain Thunbergian Plants from Japan. (Japanese). Tyôzaburô TANAKA (Bult. Sc. Fak. Terk. Kjušu Imp. Univ. **1**, 1925, 191-209).

An enumeration of a certain number of Japanese plants hitherto unidentified or misrepresented, of which the author has taken pains to identify by the examination of original specimens in the Thunbergian Herbarium in Upsala.

119. Studies in the Kao Pan Siamese Seedless Pummelo. (Japanese). Tyôzaburô TANAKA. (Jour. Sc. Agric. Soc. Japan No. 275, 1925, 288-299, 4 figs.).

The author has got from Siam, its native home several fruits and bud-sticks of the Kao Pan Siamese Seedless Pummelo (*Citrus maxima* (BURM.) MERR.). The results of his studies on them is given in this paper. The possibility of its culture in Southern Japan is discussed.

120. Horticultural Nomenclature, with Special Reference to the Revision of the Genus Citrus. (Japanese). Tyôzaburô TANAKA. (Bult. Sc. Fak. Terk. Kjušu Imp. Univ. **1**, 1925, 266-273).

The author means by "horticultural species" those occurring only in the garden, possessing distinct specific characters which can be perpetuated either by seminal or clonal propagation. As in systematic classification equal treatment of wild and garden species is logical, so far as they belong to the Linnean species, he proposes to replace the words, "horticultural varieties and hybrids" in Art. 1 of the International Rules of Horticultural Nomenclature adopted at the Brussels Congress 1910 by the words, "horticultural species, varieties and hybrids."

The author insists also on the great importance of type specimens, especially for the identification of horticultural plants, such as *Citrus*. He proposes to add a new article to the International Rules of Horticultural Nomenclature, which prescribes that the publication of new species, etc. is not valid unless the place where the type specimens are found is indicated.

121. Ueber den Ph-Wert der Fixierungsmittel (Vorläufige Mitteilung) (Japanisch). Gihei YAMAHA. (Bot. Mag. Tôkyô **39**, 1925, (164)-(167)).

1. PH-Wert von etwa 30 gebräuchlichen Fixierungsmitteln und ihren einzelnen Komponenten wirksamer Konzentrationen wird kolorimetrisch (Indikatorenreihe nach CLARK) sowie elektrometrisch bestimmt.

2. Nach ihren PH-Werten lassen sich die Fixiermittel folgendermassen in drei Gruppen einteilen:—

(a) $PH < 1.0$:—Fixiermittel von GILSON, OSTERHOUT, MERKEL, PERÉNYI, VOM RATH, RABL (Chromameisensäure), Chromtrichloressig, MAYER, KLEINENBERG, NĚMEC, HOPKER usw. Sie liefern stets ausgeprägte Bilder von sog. „Membranstrukturen“ Verfassers (frühere Mitt.), d. h. Hautschicht, Kernmembran, äussere Hülle der Chromosomen, filzige bzw. streifige Struktur des Zytoplasmas, achromatische Fasern usw.

(b) $PH = 1.1-3.0$:—Fixiermittel von FLEMMING (stärkere 1.1, Bonner 1.4, schwächere 1.6), Chromessigsäure (0.5:1:100, PH 1.3), HERMANN (1.2), GUIGNARD (1.2), MANN (1.1), BOUIN (1.3), BOVERI (1.1), JEFFREY (1.2), CARNOY (Chloroform-Alkohol-Essig) (1.1), FARMER

(1.6), LINDSAY-JOHNSON (2.2) TELLYESNICZKY (2.3), ZENKER (2.2), LENHOSSÉK (2.25), KAISER (2.4), usw. Hierauf schliesst sich JUEL (3.3) an. Diese stellen bezüglich der Fixierungsbilder Übergänge zu der Gruppe (c) dar.

(c) $\text{PH} > 3.0$:—Fixiermittel für Chondriomfixierung mit Ausnahmen von BENDA (1.2), und CHAMPY (1.4)—ALTMANN (3.9), REGAUD (3.2), BENSLEY (3.6–3.7), Bichromat (3% PH 3.9), Formol (5% PH 3.3), ZENKER (essigfrei 3.5). Diese zeichnen sich dadurch, dass sie homogenisierend auf jeden Zellbestandteil einwirken, indem vermutliche Lipoidkomponente der Zellen konserviert bleiben. Sog. „Membranstrukturen“ sind hier nicht oder nur schwerlich bemerkbar.

3. Minimale Fixierungskonzentrationen von starken Säuren (einschliesslich Trichloressigsäure) fallen gerade auf $\text{PH} = 1.4$ zusammen. Bei Platinchlorid, Bichromat, organische Säuren, und Schwermetallsalzen macht sich weiter auch Anionen-, Metallionen- bzw. Molekularwirkung geltend, wobei Wasserstoffionenwirkung auf Fixierungsbilder mehr oder minder (besonders bei Bichromat und Pikrinsäure) zurücktritt. Autor.

122. On the Behaviour of the Nucleolus in the Somatic Mitosis of Higher Plants, with Microchemical Notes. Gihei YAMAHA and Yosito SINOTÔ. (Bot. Mag. Tôkyô 39, 1925, 205–211, 1 pl. and 35 text-figs.).

The nucleolus which, contrary to the general rule, remains intact, during mitosis even in metaphase, has been sometimes reported. The authors have found such cases in the root-tips of some thirty species of cultivated forms of Phanerogams, in which they could discover besides several other karyological peculiarities. Though the morphological behaviour of such nucleoli seems to favour in general the transportation theory of the nucleolus the authors could not prove its karyotin contents by microchemical methods. Nucleoli and chromosomes are easily distinguishable microchemically from each other.

123. Supplementa Iconum Plantarum Formosanarum I, II. Yosimatsu YAMAMOTO. (Government Research Inst., Taihoku, Formosa, 1925, 47 S., 1 Taf., 20 Text-fig.).

Das vorliegende Werk enthält die folgenden neuen Arten, Varietäten, Untervarietäten und Formen der *Moraceae*, *Urticaceae*, *Aquifoliaceae* und *Convolvulaceae* aus Formosa: *Ficus cuneatonervosa*, *Pilea brevicornuta* HAYATA f. *laxiflora* und *magnifolia*, *P. cuneatifolia*, *P. distachys*, *P. Matsudai*, *P. minor*, *P. Miyakei*, *P. nokoanensis*, *Pellionia arisanensis* HAYATA var. *caudatifolia* und *pygmaea*, *P. chikushiensis*, *P. keitacensis*, *P. scabra* BENTH. var. *pedunculata*, *Memorialis Matsudai*, *M. neurocarpa*, *M. pentandra* WEDD. var. *akoensis*, *Ilex arisanensis*, *I. crenata* THUNB. var. *Kanehirai*, *I. hakkuensis*, *I. impressivena*, *I. koshunensis*, *I. Matsudai*, *I. Morii*, *I. Sasakii*, *Evolvulus alsinoides* LINN. f. *rotundifolia*, *Ipomoea tomentosa*. Verfasser.

124. Species nova Rafflesiacearum ex Formosa. Yosimatsu YAMAMOTO. (Bot. Mag. Tôkyô 39, 1925, 142–145, mit 15 Abbild.).

Ausser zwei bisher bekannten Rafflesiaceenarten, *Mitrostemon Yamamotoi* MAKINO und *M. Kanei-Sasakii* HAYATA aus Formosa wird eine neue aus derselben Insel hervorgehoben, welche der Verf. *M. Kanehirai* nennt. Sie wird lateinisch ausführlich beschrieben und illustriert.

125. Studies on the Number of Nodes of Culms in Barley, Wheat and Rice-plants. (Japanese). Morimasa YAMASAKI. (Jour. Sc. Agric. Soc. Japan, 278, 1926, 1–35, 1 pl. and figs.).

In barley and wheat we may distinguish two kinds of culms: in the one the insertion part of the spike constitutes a ridge which goes all around the rachis (N-culm), while in the other that ridge goes simply half-way round (T-culm). On the basis of teratological as well as anatomical evidence the author concludes that the T-culm is produced by the formation of one extra culm-internode of which the apex (where the spikelet is inserted) has the half-way ridge, and which is not developed in N-culm. It follows therefore that the T-culm must have in average one more internode than the N-culm, which was confirmed by the culture and observation on 58 races of barley and 86 of wheat. The relative number of T- and N-culms in each race is naturally more or less variable, though generally the number of T-culms is smaller than that of N-culms. The better nutrition, the greater moisture, and the higher temperature lead to the increase of T-culms.

In rice-plant the author could recognize the phenomena similar to those above described. Author.

126. On the Alteration of the Cell-wall in the Process of Coalification, with Special Reference to the Optical Property of the Wall. Kono YASUI. (Bot. Mag. Tôkyô 39, 1925, (289)-(297), 280-289, 1 pl.).

Optical and chemical properties of cell-membrane of various tissues of fossil plants constituting lignite and bituminous coal from about forty localities in Japan were investigated, and the alterations of cell-membrane during the process of coalification were traced. The main points of the results may be summarized as follows:

1. The double refraction is displayed in various ways in different kinds of cell walls in lignite, while this optical property is lost in bituminous coal.

2. The orientation of the axes of the indicatrix in different kinds of cell walls in lignite is the same with that of the corresponding cell wall in living plants. In the wall of tracheids, bast fibers, stone cells, and parenchymatous cells, the maximum and intermediate axes of the indicatrix are parallel to the surface of the wall and perpendicular to each other, the minimum axis being perpendicular to the surface of the wall. In the wall of cork cell, cuticle and cutinized wall the maximum axis of the indicatrix is perpendicular to the surface of the wall, and the minimum axis parallel to the surface of the wall.

3. The wall of a fossil tracheidal cell and bast fiber, whose thin section is white or bright yellow under the microscope, retains the property of double refraction, while the brown colored wall or such a part of the wall does not retain this optical property. In a tracheidal cell the property of double refraction is lost much earlier in its secondary and tertiary lamellae than in the primary lamella of the wall.

4. The wall of tracheids in lignite, even in the case when the former retains the property of double refraction like that of living coniferous wood, scarcely shows the reaction of lignified cell wall with phloroglucin and strong hydrochloric acid, while it shows the cellulose reaction with the solution of potassium iodide and strong sulphuric acid, as well as the reaction of pectin membrane with ruthenium red.

The cavity of such a tracheidal cell in lignite is generally filled with granular substance which gives the cellulose reaction with a potassium iodide or iodine solution and strong sulphuric acid.

5. The loss of the property of double refraction in the wall of tracheids in lignite is closely associated with the change of color of the cell wall, from a lighter color to a deep brown and is also accompanied by chemical changes.

6. The wall of a stone cell in lignite retains the property of double refraction far

better than that of the tracheids or bast fibers. This means that the wall of stone cells undergoes their structural alteration more gradually than those of tracheids and bast fibers. From this it seems likely that stone cells will be preserved better than those tissues mentioned above in bituminous coal. However, they might not be recognized as such, as they have mostly scattered distribution among parenchymatous tissue.

7. The suberized and cutinized wall as well as cuticle do not show the phenomenon of double refraction so strongly as the wall of well preserved tracheids, bast fibers or stone cells.

8. The wall of a parenchymatous cell in lignite and bituminous coal does not retain the property of double refraction except some cases of lignified wall, where this property is retained. In the latter case, the wall retains cellulose nature, so far as the reaction of potassium iodide of iodine solution and sulphuric acid is concerned.

9. From several facts ascertained by the writer, we may infer that in the process of coalification cellulose and most likely pectin substance too are largely removed in a comparatively earlier stage. This may be an alteration of the micellar arrangement as well as the molecular arrangement in the micels themselves of the remaining constitutional parts of the wall. At the same time the property of double refraction is lost.

Author.

127. Description of Internal Structure of Remains of a Tertiary Moss.
Kono YASUI. (Bot. Mag. Tôkyô 40, 1926, 15-18, 1 pl.).

This paper is concerned with a description of the anatomical structure of a fossil specimen found in lignite from Aichi coal field, Upper Tertiary in Central Japan. The specimen showed an epidermis with neither stomata nor trichomes, the cortex consisting of outer thick-walled tissue and inner thin-walled parenchyma, and the central cylinder consisting of the central xylem of simple structure and the outer badly preserved phloem. By the comparison of the fossil specimen with *Polytrichum* of the present day the author could observe the remarkable coincidence between the two, not only as to their structure, but also as to their optical properties of the cell wall. From all these facts the author came to the conclusion that the fossil specimen is a seta of a moss belonging to Eryeae, and gave it the name *Bryotrichum aichiense*.

Author.

128. Ueber die Bedingungen des Pharbitis-Samens mit besonderer Rücksicht auf die Keimungsfähigkeit des unreifen Samens. Yoshiji YOSHII. (Jour. Fac. Sc. Imp. Univ. Tokyo, Sect. III (Bot.) 1, 1925, 1-139, 1 Tafel und 20 Textfig.).

Den Inhalt der vorliegenden Abhandlung betreffend die Samenreife von *Pharbitis Nil*, welche eine grosse Anzahl von einzelnen Tatsachen enthält, kann man kaum in diesem kurzen Résumé eingehend referieren. Der folgende ist eine sehr knappe Uebersicht des wichtigsten Inhaltes.

Innerhalb drei Wochen nach der Befruchtung erreicht der Same sein Vorreifstadium, welches 4-5 Tage andauert, dann kommt das ungefähr zwei Wochen langes Grünreifstadium, während welches der wichtigste Reifevorgang stattfindet, d. h. die Aufspeicherung und Umwandlung der für die Keimung nötigen Reservestoffe. Der danach völlig ausgebildete Samen tritt nach 4-7 Tagen in seinem Vollreifstadium ein. Die Keimungsenergie der Samen steigt mit der Reifung, und zwar sind die Samen, die im Grünreifstadium wenig auskeimen können, im Vollreifstadium zum grössten Teile keimfähig.

Wenn die Samen im Vorreifstadium noch nicht keimfähig ist, ist der befreitete Embryo schon im Wasser keimfähig. Vor diesem Stadium können die befreiteten

Embryonen im Wasser ohne weiteres nicht entwickeln ; es gelang jedoch dem Verf., sie in einer gewissen künstlichen Nährlösung (Knors Lösung+Rohrzucker+Asparagin) zur Entwicklung zu bringen. Nachdem solche Embryonen eine gewisse Grösse erreicht hatten, kann man daraus die Pflanzen bekommen, und zwar durch die Kultur in anorganischer Lösung im Lichte.

129. Vorläufige Untersuchungen über Myxobakterien in Japan. Yoshiji YOSHII. (Sc. Rpts. Tōhoku Imp. Univ. **1**, 1926, 277-291).

Myxococcus ruvescens und *virescens* sind die in Japan häufig vorkommenden, und am ergiebigsten über Hasen- und Hirschmist befindlichen Myxobakterien. Die erstere Art ist leicht kultivierbar, z. B. auf Kartoffeldekotagar, aber die letztere ist nicht, wofür jedoch der Verf. einen guten Nährboden gefunden hat, wo sie gut und leicht die Fruchtkörper bilden kann, nämlich das *Tofuagar*, welches durch Abkochen von Bohnengallert (=Tofu)-Rückstand hergestellt wird.

Bezüglich der physiologischen Eigenschaften, verflüssigt *M. ruvescens* Gelatine, *M. virescens* nicht. Die letztere Art scheidet einen fluoreszierenden gelben Farbstoff aus. *M. ruvescens* verflüssigt Agar, *M. virescens* nicht. Durch Impfung von *M. ruvescens* auf Milchagar kann man das Vorhandensein von proteolytischen Enzymen beweisen, aber durch die gleiche Impfung der anderen Art kann man keine proteolytische Erscheinung beobachten. Beide gedeihen gut in gewissen Nährflüssigkeiten, wobei es herausgestellt hat, dass *M. ruvescens* eine mehr peptonliebende Art ist, als die andere. Hinsichtlich der Reaktion des Nährbodens kann *M. virescens* viel stärkere saure Reaktion vertragen als die andere. Wenn die Farbe des Fruchtkörpers sehr modifizierbar ist, kann man die ursprüngliche Farbe auf bestimmtem Nährboden zurückgewinnen, sodass man die Farbe der Myxococcen als ein charakteristisches Unterscheidungsmerkmal ansehen kann.

Abstracts No. 130-217

(Referring to the principal papers on Botany and allied subjects which have appeared in Japan mostly during March-September 1926)

130. On the Infection Experiments of Rust-fungi by using the Petri-dishes (Japanese). Takuzi ABE. (Jour. Plant Protection **13**, 1926, 7 pp., 1 fig.)

Some infection experiments of rust-fungi according to the method of CLINTON who uses the PETRI-dishes, more or less modified were done. The author has got generally positive results, and thinks the method well fitted for his purpose.

131. Preliminary Report of Self-sterility of Japanese Pears. Yoshichi ASAMI. (Proc. Imp. Acad. **2**, 1926, 139-141).

The Japanese variety of pear Chôjûrô is highly self-sterile. The examination of its self-pollinated flower has revealed the fact, that in the material taken 7 days after the pollination no tube was found which reached even the locule of the ovaries. On the contrary, in the flowers of this variety \times another or its reciprocal fertilisation many tubes were found which have reached the micropyle already after 4 days; in the material taken 7 days after the pollination a few ovules were found where the egg-cell is already bicellular and several endosperm-cells have been produced. The author's conclusion is that the self-sterility of Chôjûrô must be due either to a slow rate of pollen tube growth or to a certain check against its growth. In Chôjûrô the pollen-tube was found to pass through the conducting tissue inside the style.

Author.

132. Guide-books of the Excursions. Published by the Japanese National Research Council, 1926.

These booklets, altogether 25 in number, published on the occasion of the Third Pan-Pacific Science Congress held Oct. 30th—Nov. 11th. 1926, contain the following articles which are of botanical interest.

Shunsuke KUSANO: The Forest Vegetation of Nikkô (6 pp.)

Bunzô HAYATA: Guide to the Botany of the Hakone Mountains (34 pp., 18 pls.)

Bunzô HAYATA: Guide to the Botany of Mt. Fuji (42 pp., 38 pls.)

Bunzô HAYATA: Guide to the Botany of Kamakura and Enoshima (10 pp., 8 pls.)

Kwan KÔRIBA: Botanical Notes on Central Kinki District (9 pp., 4 text-figs.)

Kwan KÔRIBA and Zentaro TASHIRO: Botanical Notes on the Beppu District (2 pp.)

Kwan KÔRIBA and Zentaro TASHIRO: Botanical Notes on the Unzen Park and Shimabara Peninsula (6 pp., 1 pl.)

Bunzô HAYATA: Guide to the Botany of the Island of Miyajima (11 pp., 10 pls.)

Kwan KÔRIBA and Zentaro TASHIRO: Botanical Notes on Mt. Aso (3 pp., 1 text-fig.)

Harufusa NAKANO: On the Vegetation of Aoshima (5 pp., 1 text-fig.)

Kwan KÔRIBA and Zentaro TASHIRO: Botanical Notes on Sakura-jima (3 pp., 1 pl.)

133. Genetic Studies of Corolla-pattern in the Morning Glory. II. On the Six Kinds of Corolla-pattern. (Japanese with English résumé). Tokio HAGIWARA. (Bot. Mag. Tôkyô **40**, 1926, 203-225, 8 figs.)

1. "Hukurin"—the coloured flower with white edge—behaves as dominant to the normal, but there is other "Hukurin" which behaves as recessive.

2. The factor H having the potency to inhibit "Hukurin" has the tendency of transforming itself to the recessive allelomorph.

3. No linkage takes place between the factor U_a for the dwarf character and F for "Hukurin".

4. The coupling of high intensity takes place between the factor f and n_o for the green stem with coloured nodes.

5. "Fukiageshibori"—the flower where the colour gradually fades away from the center towards margin—behaves as recessive or dominant to the normal.

6. There is a factor which inhibits the appearance of "Fukiageshibori".

7. "Hakutenshibori"—the coloured flower with white spots and blotches—is a corolla-pattern due to the cooperation of the two dominant factors.

8. Each one of these two factors is linked with the factor U , and the gametic ratio of these linked factors is about 5 : 1.

9. "Shimashibori"—the striped flower as in some Snapdragon—behaves as recessive to the normal.

10. The factor s_i concerning the striped flower is transformed eversportingly to S_i at some percentage.

11. "Gotokoroshibori"—the coloured flower which has large pale spots at the center of every petal—behaves as recessive to the normal. This character is due to the factor s_g with F .

12. "Nejumezaki"—where the flower is twisted along the contact line of the corolla and the tube—behaves as recessive to the normal.

13. "Sujigane"—the flower in which on account of certain hard parts the petals can not open completely—behaves as the recessive allelomorph to the normal, and the factor for this character may be considered to be linked with the factor u for the common contracted strain.

Author.

134. Genetic Studies of Leaf-character in Morning Glories. V. On some Mutants and their Genetic Behaviour. (Japanese with English résumé). Tokio H. GIWARA. (Bot. Mag. Tôkyô 40, 1926, 226-235, 1 fig.)

Through the allelomorph-transformation which takes place during the production of the gametes in the F_1 plant, the so-called "Giant type" appeared as a mutant in the F_2 of a crossing between certain normal ones. It behaves as a simple Mendelian recessive to the normal, and is due to the presence of two factors. By raising the F_3 generation, it was observed that the one of these recessive factors is liable to transform to the dominant one at the period of the gamete-production. In the F_2 generation of a certain crossing, a few individuals having the abnormal leaf-stalk twisted spirally were found among the normals, especially at the beginning of the growing period. The appearance of this character in F_2 which has not been exhibited by the parents, may be due to the allelomorph-transformation. This character behaves as a recessive to the normal; for this two recessive factors are concerned, one of which is that for "Kudiyakuba". Concerning the leaf-character, the mutant plants—grayish green leaved as well as green yellowish variegated leaved—were found in a pedigree of the F_3 generation of a certain cross.

The allelomorphic transformation $g-G$ takes place eversportingly, g and G being for the yellow and the green leaf respectively.

Author.

135. Genetic Studies of the Fasciation in Morning Glories. (Japanese with Entries 134-135)

English résumé). Tokio HAGIWARA. (Bot. Mag. Tôkyô **40**, 1926, 281-294, 5 figs.) The fasciation of plants is either inborn or acquired. As the fasciation in Morning-Glory belongs to the former, the plant bearing this character breeds true.

The morphological and physiological study of the character in this plant has been carried out through the water culture and the microscopic treatment by Mr. Y. YAMAGUCHI in 1916. The results of its genetic study was reported preliminarily by the author in 1923. By raising further generation in 1924, he was able to prove that the fasciation is due genetically to the cooperation of two recessive factors, of which one is p for "Kudyakuba" (i.e. the leaf-shape gene) the other f' being able to produce the fasciation only in the presence of the recessive gene p .

Considering Mr. YAMAGUCHI's conclusion that the suitable density of the KNOP's solution for the development of this character is 5%, the author will consider that the favorable density for developing the activity of these genes is 5%.

A few normal individuals found among the offspring of the fasciated parent is not due to the result of such external influence, but to the factor-transformations, as:
 $p \rightarrow P, f \rightarrow F$. Author.

136. Genetic Studies on Impatiens Balsamina. I. (Japanese with English résumé). Tokio HAGIWARA. (Bot. Mag. Tôkyô **40**, 1926, 293-306, 5 figs.)

1. The camellia double flower behaves as a Mendelian recessive to the common double flower, and the factor for this camellia double flower gives manifold effects to leaves and growing habit.

2. The crossing between the single flower and the common flower gives the single-flowered hybrids, and these latter give in F_2 the single flowers and the common double ones in the ratio 9 : 7.

3. The factors producing the flower-colour of this plant are as follows:— M for the red flower; m for the pink flower; P changes the pink flower into purple, and produces with M the reddish purple colour.

4. Some white flowers produce eversportingly the colour-flowered and the striped-flowered mutants.

5. A fasciated plant appeared among the normals, it may perhaps be the new mutant. Author.

137. Pathogenicity of Piricularia Oryzae on the Rice-seedlings. (Japanese). Takewo HEMMI and Kuniomi YOKOGI. (Agriculture and Horticulture, **1**, 119-130, 1 pl., 1926.)

The method of the cultivation of the rice plant is quite different from that of other cereals, and the proper preparation of the land for the seedlings to be transplanted is most important to obtain the strong and healthy plants. The investigation of the rice seed-beds from the phytopathological standpoint has been, however, much neglected. The experimental studies on the pathogenicity of the fungi which have the possibility to be associated with the seed and soil are, therefore, not only of scientific interest but also of practical importance. This paper is a part of an investigation on the pathogenicity of several fungi on the rice-seedlings to solve the above stated problem.

According to our experiments *Piricularia Oryzae* Br. et Cav. isolated from the diseased leaf has a power to infect the foot and root of the rice seedlings, although it is not a virulent root parasite. This fact is very interesting, for the fungus is most common and destructive to the rice plant on its leaves and stems. The observation on the pathogenicity of the fungus on the seed and the root of the seedlings in the seed-beds

under natural condition is not yet done, but it may be safely presumed that the rice seedlings have the tendency to be attacked by this fungus, if they are planted in the seed-beds favorable for the fungus growth. Authors.

138. Studien über *Azotobacter chroococcum*. (Japanisch.) SIKAZÔ HITOMI. (Jour. Sc. Agric. Soc., Nr. 282, 1926, 206-210.)

Der Verf. studiert die chemischen Wirkungen von *Azotobacter chroococcum* gegen Harnstoff und Salpetersäuresalzen, sowie seine Produktion von Ammoniak und salpetriger Säure während der Kultur.

139. Revisio Graminum Japoniae IX. MASAJI HONDA. (Bot. Mag. Tôkyô 40, 1926, 97-109.)

Andropogon intermedius, R. BROWN var. *punctatus*, HACKEL which is distributed in tropical Africa, Nepal and China, is for the first time recognized by the author to occur in Formosa.

Andropogon micranthus, KUNTH var. *villosulus*, HACKEL which occurs in Nepal and China, is also known to be new to the Korean flora.

The generic name *Holcus* LINNÉ being better to be adopted instead of *Sorghum* PER-
soon, the following names and combinations are used.

Holcus halepensis, LINNÉ

var. *genuinus*, HONDA

var. *muticus*, HONDA

Holcus Sorghum, LINNÉ

var. *obovatus*, HONDA

subvar. *typicus*, HONDA

subvar. *niger*, HONDA

var. *Arduini*, HONDA

subvar. *japonicus*, HONDA

var. *transiens*, HONDA

Holcus fulvus, R. BROWN

var. *genuinus*, HONDA

var. *nitidus*, HONDA

var. *piliferus*, HONDA

Holcus Fauriei, HONDA is a new species which occurs in Formosa only.

Rhaphis of LOUREIRO having the priority to *Chrysopogon* of TRINICUS, the new combination *Rhaphis aciculatus* HONDA is proposed by the author in place of *Andropogon aciculatus* RETZIUS or *Chrysopogon aciculatus* TRINICUS.

Heteropogon contortus BEAUVOIS var. *hispidissimus* HONDA which occurs in Java and Abyssinia is a new combination instead of *Andropogon hispidissimus* or *Andropogon contortus* var. *genuinus* subvar. *hispidissimus* HACKEL, and belongs to the flora of Formosa.

The new combination *Cymbopogon Geringii* HONDA is proposed instead of *Andropogon Geringii* STEUDEL or *Andropogon Hardus* subsp. *marginatus* var. *Geringii* HACKEL. This grass is widely distributed in Japan proper, Bonin, Formosa, Corea, China and Philippines. *Cymbopogon hamatulus* HONDA is the other new combination in place of *Andropogon hamatulus* NEES or *Andropogon Nardus* subsp. *hamatulus* HACKEL which is distributed in Formosa, China and Philippines.

Themeda triandra FORSKAL var. *vulgaris* HONDA is a new combination founded on *Themeda Forskalii* var. *vulgaris* HACKEL. It occurs widely in tropical region, and also

in Japan proper.

Themeda caudata HONDA is combined anew instead of *Anthistiria caudata* NEES or *Themeda gigantea* subsp. *caudata* HACKEL; and *Themeda caudata* var. *Matsudai* HONDA is a new variety which has pilose involueral spicules. The type occurs in China, North India and Formosa, the variety in Formosa only.

Dimeria higoensis HONDA is a new species which is discovered at a certain place in Kiusiu.

The author's old name *Osterdamia liukiensis* HONDA is transferred to *Zoysia liukiensis* HONDA.

Arundinella glauca KOIDZUMI is to be changed into the new combination *Arundinella hirta* var. *glauca* HONDA. Author.

140. Revisio Graminum Japoniae X. Masaji HONDA. (Bot. Mag. Tôkyô 40, 1926, 317-329, with a Japanese résumé).

The grasses described in this paper are as follows:—

<i>Anthoxanthum nipponicum</i> , HONDA sp. nov.	Hondo.
var. <i>Furumii</i> , HONDA var. nov.	Corea.
<i>Anthoxanthum japonicum</i> , HACKEL	Hondo, Shikoku.
Syn. <i>Hierochloë japonica</i> , MAXIMOWICZ	
<i>Anthoxanthum formosanum</i> , HONDA sp. nov.	Formosa.
<i>Hierochloë monstrosa</i> HONDA nom. nov.	Yezo.
Syn. <i>H. alpina</i> var? <i>monstruosus</i> , KOIDZUMI	
<i>Stipa effusa</i> , NAKAI	Sachalin, Yezo, Hondo, Corea.
Syn. <i>Stipa sibirica</i> var. <i>effusa</i> , MAXIMOWICZ	
<i>Muchlenbergia incumbens</i> , HONDA sp. nov.	Kiusiu.
<i>Sporobolus piliferus</i> , KUNTH	Hondo, Shikoku, Corea.
Syn. <i>Vilfa pilifera</i> , TRINIUS, <i>Sporobolus ciliatus</i> , PRESL.	
<i>S. ciliatus</i> var. <i>japonicus</i> , HACKEL, <i>S. japonicus</i> , MAXIM.	
<i>Cinna latifolia</i> , GRISEBACH	Sachalin, Hondo, Corea.
Syn. <i>Cinna pendula</i> , TRINIUS	
<i>Agrostis palustris</i> , HUDSON	Sachalin, Yezo, Hondo, Kiusiu.
Syn. <i>Agrostis alba</i> , WILLDENOW	
var. <i>aristata</i> , HONDA nom. nov.	Hondo.
Syn. <i>A. alba</i> var. <i>aristata</i> , BOISSIER.	
<i>Agrostis canina</i> , LINNÉ	
var. <i>mutica</i> , GAUDIN	Corea, Formosa.
Syn. <i>A. canina</i> var. <i>formosana</i> , HACKEL	
<i>A. transmorrisonensis</i> , HAYATA	
<i>Agrostis flaccida</i> , HACKEL	
var. <i>morrisonensis</i> HONDA nom. nov.	Formosa.
Syn. <i>A. morrisonensis</i> , HAYATA.	
<i>Calamagrostis aspera</i> , HONDA sp. nov.	Hondo.
<i>Calamagrostis orthophylla</i> , HAYATA et HONDA sp. nov.	Hondo, Shikoku.
<i>Calamagrostis Pseudo-Epigeios</i> , HONDA sp. nov.	Formosa.
<i>Calamagrostis nitakayamensis</i> , HONDA sp. nov.	Formosa.
	Author.

141. Revisio Graminum Japoniae XI. Masaji HONDA. (Bot. Mag. Tôkyô 40, 1926, 435-445, with a Japanese résumé).

The following plants are contained in this article:—

Entries 140-141

<i>Avena Hideoi</i> , HONDA sp. nov.	Hondo.
<i>Avena fatua</i> , LINNÉ	
var. <i>glabrata</i> , PETERMANN	Hondo, Kiusiu, Corea.
<i>Arrhenatherum elatius</i> , MERTENS et KOCH	Yeze, Hondo.
Syn. <i>Arrhenatherum avenaceum</i> , BEAUVOIS	
<i>Chloris barbata</i> , SWARTZ	
var. <i>formosana</i> , HONDA var. nov.	Formosa.
Syn. <i>Chloris barbata</i> , (non SWARTZ) A. HENRY	
<i>Dactyloctenium ægyptium</i> , RICHTER	Liukiu, Formosa, Bonin.
Syn. <i>D. ægyptiacum</i> , WILLDENOW	
<i>Calamagrostis Matsudana</i> , HONDA sp. nov.	Formosa.
<i>Calamagrostis sublanccolata</i> , HONDA sp. nov.	Formosa.
<i>Calamagrostis suizanensis</i> , HONDA nom. nov.	Formosa.
Syn. <i>Agrostis suizanensis</i> , HAYATA.	
<i>Calamagrostis arisanensis</i> , HONDA sp. nov.	Formosa.
<i>Calamagrostis heterogluma</i> , HONDA nom. nov.	Corea.
Syn. <i>C. longiseta</i> var. <i>heterogluma</i> , NAKAI	
<i>Calamagrostis arundinacea</i> , ROTH	
var. <i>ciliata</i> , HONDA var. nov.	Formosa.
var. <i>inaequata</i> , HACKEL	Corea.
var. <i>robusta</i> , NAKAI	Hondo, Shikoku, Kiusiu.
Syn. <i>C. robusta</i> , FRANCHET et SAVATIER	
<i>Poa crassinervis</i> , HONDA sp. nov.	Kiusiu.
	Author.

142. Triploidy of Chromosomes in Garden Varieties of *Primula Sieboldii* E. Morr. Masajiro IINUMA. (Sc. Rpts. Tôhoku Imp. Univ. IV. Ser., 2, 1926, 189-195, 3 figs.)

The chromosome number in the pollen mother-cells in wild specimens of *Primula Sieboldii* was found to be 12. The author has examined several garden varieties of this species, and has observed that the diploid chromosome number is 24 in their majority, but 36 in some varieties. The latter are to be considered to be the triploid mutants, and may reasonably supposed to have been produced by the union of the diploid germ-cells with the normal haploid ones. Further, the author has compared the size (length and width) of stomata of the diploid and triploid varieties, and found that it is larger in the latter than in the former.

143. On the Culture of Swarmspores of *Ecklonia bicyclis* Kjellm. (Japanese). Jiro IKARI. (Jour. Fisch. 29, 1926, 13-16, 1 pl.)

The swarmspores of *Ecklonia bicyclis* is pear-shaped, biciliate, with no eye-spot, $9 \times 5\mu$; each contains one nucleus, one chromatophore, and many fucosan grains. Two or three days after they have entered the resting stage, they become the embryospores. From the latter the dioecious gametophytes are produced, the male being easily distinguishable from the female by their slenderness and much more complex mode of ramification. The oospores are oval, and $32 \times 20\mu$. The author was able to follow their development to the beginning of the so-called post-embryonal stage.

144. Genetic Studies in Morning Glories. XVI-XVII. (Japanese with an English résumé). Yoshitaka IMAI. (Bot. Mag. Tôkyô 40, 1926, 446-449, 1 fig.; 496-498).

The Matsushima-lined yellow leaves give a few green mutants (about 3.5%) and some

Matsushima or green-variegated yellows (about 20%) in their progeny, and the type is transmitted as a recessive to the green. Such unusual behaviors of the Matsushima-lined yellows are due to a factor which gives habitually the mutations of yellow into green.

1. The factors for the white margin in the Japanese morning glory are

$F^a, f^a > F^a$ and F^b work complementarily for the formation of the white margin. Neither factor can produce the white margin by itself.

$F^h, f^h - F^h$ acts as a complete inhibitor.

$F^f, f^f - F^f$ acts as a partial inhibitor.

2. f^a is linked with d (contracta) with about 1% crossovers, and f^b with n_n (Nandina) with approximately 0.5%.
3. F^f is linked with c (white flower with colored stem), the frequency of crossover being roughly 20%.

Author.

145. Additional Note on Uromyces of Japan. Seiya ITO. (Bot. Mag. Tôkyô 40, 1926, 276-280, with figs.)

Contains the notes on *Uromyces Gageae* G. BECK., *U. Hyperici-frondosi* (SCHW.) ARTH., *U. truncicola* P. HENN. et SHIRAI, *U. shikokianus* KUSANO, and the description of a new species, *U. Peracarpae* ITO et TOCHINAI.

146. Miyabella, a new Genus of Synchytriaceæ. Seiya ITO and Yasu HOMMA. (Bot. Mag. Tôkyô 40, 110-113).

Synchytrium Puerariae and *S. decipiens* were transferred to the genus *Woroninella* by H. SYDOW. The latter genus is characterized by the formation of biciliate zoospores, while those of *S. Puerariae* are uniciliate according to KUSANO. Since the authors could prove the presence of uniciliate zoospores in both *Synchytrium* species above mentioned, they have created for them a new genus *Miyabella* which contains two species, *M. Puerariae* (= *S. Puerariae*) and *M. decipiens* (= *S. decipiens*).

147. Yeasts isolated from Flower Nectar. Tadao JIMBO. (Rpts. Tôhoku Imp. Univ. IV. Ser., 2, 1926, 161-187, 2 pls.)

The author has investigated the nectar of 273 flowers of 23 species of plants growing in Sendai, and found that almost all flowers of the species tested are infected by yeasts, of which he could distinguish 22 forms. The same forms of yeasts were found in the nectar of various plants, and also of those in different places, towns, fields, mountains, etc. The rate of infection increases with the seasonal rise of temperature.

No ascospore formation has been observed, nor was the alcohol fermentation manifest with various sugars. The so-called "Kreuzform" was rarely seen. In one form the formation of oil-drops, either intra- or extracellular, was seen.

The author gives the tables indicating the details concerning all forms of yeasts isolated by him.

148. Observation on the Size and Shape of Chromosomes based upon their actual Measurement. Fuyuwo KAGAWA. (Proc. Imp. Acad. 2, 1926, 136-138).

By the usual observation the length of the chromosome parts lying on the plane perpendicular to the microscopic axis can be correctly estimated, but the parts lying at some angle to the same plane present to the observer the foreshortened views. To know their true length the author has projected the foreshortened parts on the plane perpendicular to the microscopic axis according to the principles of solid geometry. By this

method he has measured 14 chromosomes of root-tip-cells of *Triticum monococcum* in metaphase, anaphase and late prophase. He could distinguish the three length classes of chromosomes, large, middle, and short. Each chromosome is constricted, and the spindle-fibre is inserted at this constricted part. The absolute length of each chromosome is more or less different in different cells, but its relative length to the total one of all chromosomes in the corresponding nuclei is nearly constant. Author.

149. Anatomical Characters and Identification of the Important Woods of the Japanese Empire. (Japanese). Ryôzô KANEHIRA. (Rpt. Dept. Forestry, Govern. Res. Inst., Taihoku, Formosa **4**, 1926, 297 pp., index 7 pp., 31 pls.)

The work is divided into the general and the special part. The former (p. 1-117) contains the following 6 chapters, each of which consists of one or more sections: 1. External features of woods, 2. Distinction of woods according to their chemical features, 3. Anatomical characters of woods in general, 4. Anatomical characters of needle-tree woods, 5. Anatomical characters of foliage-tree woods, 6. Methods of treatment of woods to be studied. The special part (p. 118-297) begins with an extensive analytical key of woods according to their anatomical features. Then follows the description of the distribution, external and anatomical features as well as practical use of 51 needle-trees and 265 foliage-trees. The anatomical characters are richly illustrated by collotype plates.

150. On the Anthocyanin Pigments of Morning Glory. Takesi KATAOKA. (Proc. Imp. Acad. **2**, 1926, 274-276).

151. On the Constitution of Coptisine, a new Alkaloid from Coptis japonica. Zenjiro KITASATO. (Proc. Imp. Acad. **2**, 1926, 124-125).

152. Über das Wachstum der Stärkekörner und die bimodale Variationskurve in Bezug auf die Grösse der Stärkekörner in den Keimblättern von Nelumbo nucifera Gärtn. Kogane KIYOHARA. (Bot. Mag. Tôkyô, **40**, 427-434, 2 Textfig.)

Verfasser hat bei *Nelumbo nucifera* den täglichen Wechsel der Variationskurve der Stärkekörnergrösse während des Wachsens des Samens verfolgt. Die anfängliche Variationskurve der Körnergrösse d.h. dieselbe am 15ten Tage nach der Bestäubung stellt eine symmetrische Kurve dar, wobei die Stärkekörner stets ellipsenförmig sind, doch ist die am 18ten Tage hergestellte Variationskurve nicht mehr symmetrisch, sondern zeigt sie eine kleine Ausbuchtung an dem Fusse der Kurve. Diese zweite Mode tritt am 25ten Tage nach der Bestäubung am deutlichsten hervor, und ergibt das Bild zweier Kamelhöcker, wobei zahlreiche rundliche Stärkekörner nebst den ellipsenförmigen gefunden werden. Dann verkleinert sich der zweite Mode allmählich und am 31ten Tage wird die Kurve wieder monomodal und asymmetrisch. Aus diesem täglichen Wechsel der Variationskurve und der statistischen Berechnung ist Verfasser zum Schlusse gekommen, dass zahlreiche rundliche Stärkekörner gegen den 18ten Tage nach der Bestäubung sekundär gebildet werden, und, dass diese sekundäre Bildung der Stärkekörner wahrscheinlich die oben geschilderte Zweigipfeligkeit der Variationskurve verursacht, so dass die bei *Nelumbo* hier gefundene zweigipfelige asymmetrische Variationskurve eine zusammengesetzte Kurve darstellt, die eigentlich in zwei selbständige Kurven zerlegt werden soll.

Verfasser.

153. Contributions ad Cognitionem Floræ Asiæ Orientalis. Gen'iti KOIDZU-MI. (Bot. Mag. Tôkyô **40**, 1926, 330-348).

Contains besides many new names by the author and the remarks on various species the description of the following new species, *Fraxinus lanuginosa* Koidz., *Salix pseudo-koreensis* Koidz., and *Hydrangea yessoensis* Koidz.

154. Variation of the Transpiring Power of Leaves as Related to the Wilting of Plants. Riichiro KÔKETSU. (Jour. Dept. Agr. Kyushu Imp. Univ. **1**, 241-260, 1926.)

The variation of the foliar transpiring power of plants was studied by means of standardized hygrometric paper in *Coleus*, wheat and soy bean plants. The plants used were cultivated in various samples of soil having different water holding capacity. The experiments were made both on the rooted and uprooted plants. The average value of the indices determined in different individuals was taken into consideration.

The variation of the foliar transpiring power during the process of wilting was considered from two points of view, namely the variation of the transpiring power itself, and the variation of the amplitude of the daily fluctuation or the "day-night ratio" of this power.

This ratio of the plants approached in the wilting process nearer and nearer to unity. But after that time it tended in many cases to become less than unity, because the night index became higher than the day index.

The index of the transpiring power itself decreased progressively during the wilting, until it reached its minimal value at the critical point of wilting, corresponding to the time of permanent wilting. After that time it began again to rise more or less, and then the plants fell into the drying phase of low transpiration.

The value of the critical index seemed to be practically constant for a given plant species, regardless of plants rooted or uprooted. The critical index found in the three mesophytic species used appeared to be approximately alike. But although the difference between them was rather slight, it was suggested that the critical index in question is characteristic for each kind of plants.

The soil moisture residue at the time of critical state of wilting was also determined, and it was found that this residue is affected more or less by the nature of plants, although affected more conspicuous by the nature of soils.

Both the index of the transpiring power of a plant and this soil moisture residue seemed to be smaller, when the plant had greater drought resistance. Therefore these two values might be applied as the measure of the comparative xerophytism of plant.

Author.

155. Studies on the Foliar Transpiring Power and its Daily Fluctuation as Related to the Development of Leaves in *Coleus blumei*. Riichiro KÔKETSU. (Bot. Mag. Tôkyô, **40**, 1926, 122-131.)

The transpiring power of the leaves of different degree of development in *Coleus blumei* was studied by means of standardized hygrometric paper. The plants cultivated in various samples of soil were used, the leaf-tests being made four times a day on each leaf of each plant.

The transpiring power on the lower surface of leaves was found to be the highest in the leaves of the height of development, while in both younger and older leaves it was lower. On the other hand, the power on the upper surface was lower in the former than in the latter. A leaf as a whole showed greater power, when situated lower. But the uppermost leaf had somewhat higher value than that of the one situated next to it.

The daily fluctuation of the power in question was greater on the lower than on the upper. The higher the development of leaves, the greater was found the variation

of the power on both surfaces of leaf, while old leaves showed again a lower degree of fluctuation.

All the phenomena mentioned above are probably caused above all by the function of the stomata. Author.

156. Ueber die Dauer der Erhaltung der Keimkraft bei verschiedenen Samenarten in Japan. Mantarô KONDÔ. (Ber. Ôhara Inst. Landw. Forsch. Kuraschiki, **3**, 1926, 127-133). Siehe Jap. Jour. Bot. **3**, 1926, Abstract Nr. 27.

157. Ueber die Einwirkung des Kalks auf die Erhaltung der Keimkraft von Samereien. Mantarô KONDÔ. (Ber. Ôhara Inst. Landw. Forsch. Kuraschiki, **3**, 1926, 135-146). Siehe Jap. Jour. Bot. **3**, 1926, Abstract Nr. 30.

158. Ueber die Erhaltung der Keimkraft von Samereien und über Trocknungsmittel. Mantarô KONDÔ. (Ber. Ôhara-Inst. Landw. Forsch. Kuraschiki, **3**, 1926, 147-151). Siehe Jap. Jour. Bot. **3**, 1926, Abstract Nr. 31.

159. The Storage of Rice and Change of its Physical Properties during this Period. Mantarô KONDÔ. [Ber. d. Ôhara Inst. f. Landw. Forsch. Kuraschiki **3**, 1926, 153-175] [Also Ôhara Nôgyô Kenkyûjo Tokubetsuhôkoku, **2**, 1925 (Japanese)].

In Japan at present the storage of rice is carried generally in the state of hulled rice. The hulled rice however, being much damaged by insects and mould, it is a very important problem to study a rational method of storing. From 1915 until to-day the writer has studied the problem of storing rice, particularly about the change of physical properties of hulled rice during the time of storage. The several kinds of rice were stored in a granary of the Ôhara-Institute. The results are as follows:—

1. The temperature of hulled rice in a straw-bag is always different from the granary temperature. In summer and autumn the former is higher than the latter generally, but in the upper part of a granary it is just contrary, because the air temperature increases much more than the rice temperature with the height in a granary.

2. In winter and spring, on the contrary, the rice temperature is always lower than the granary temperature and in the upper part of a great granary they are the same.

3. As the granary and rice temperature rise very much with the height, it is very important in a hot season to prevent the increase of temperature in the upper part of the granary by good ventilation or some other equipments.

4. The temperature of rice varies mainly with the air temperature of the granary, but the moisture of rice and also several kinds of insects in the straw-bags play a great rôle in the raising of the rice temperature.

5. The humidity of the air in a granary decreases with the increase of height and it is important by some equipments to dry the air in the lower part of the granary.

6. According to the season, the moisture of rice grains varies greatly; in June and July it is greatest, and in December and January least; since it is greatly affected by the atmospheric humidity.

7. If various kinds of rice of different moisture are stored together, it will be seen that their moisture gradually changes approaching to each other and finally almost coinciding, but after several years the rice grains lose water gradually and become dry. In this case it is observable that the rice that was in the beginning driest lost most water. At last the moisture of rice grains becomes very different according to the degree of dryness of the grains in the beginning.

8. If rice is stored a long time in straw-bags in a granary, its moisture decreases gradually during the years that they are stored.

9. The volume or weight of hulled rice grains varies greatly according to the season; in July, August, September it is small, least in August, in January and February great, greatest in January, since it is greatly affected by the atmospheric humidity.

10. In general, the volume or weight of hulled rice grains increases gradually during the time of storage. When the grains were damaged by insects, however, their volume weight decreases suddenly.

11. The water absorbing capacity and swelling ability in water of rice, which is stored in straw-bags, decreases regularly with the length of storage. Let x be the number of months, during which the rice grains are stored, let y be the percentages of increase in volume or weight and let a and n be constants, then there will result the following equation: $y = ax^n$.

12. By experiments and calculations the constants a and n in the equation can be determined. Take any hulled grain in storage. If the percentage of increase in volume or weight of grains in water is determined then the number of months of storage of the rice grains can be easily found by the equation.

13. When rice grains are soaked in water, the percentage of increase in volume is much greater than that of weight.

14. The moisture of rice grains has an effect upon the water absorbing capacity and swelling ability, but this effect is much slighter than that caused by the length of storage. Notwithstanding the seasonal variation in the moisture of the grains, the water absorbing capacity and swelling ability of water-soaked rice grains vary very little with the season.

15. The hardness of the rice kernels stored in straw-bags decreases with the lapse of time during the first 2-3 years, but after several years it increases again.

16. According to the season, the hardness of rice grains varies greatly, since it is greatly effected by the atmospheric humidity. In July—September it is least, in November—February greatest.

17. The material lost by polishing the rice grains decreases with the length of storage, when the rice is stored without the damage by insects and mould.

18. According to the season, the material lost by polishing varies greatly. In July and August it is greatest and in December-February least, because it is greatly affected by the atmospheric humidity.

19. The hulled rice in straw-bags keep its germination power until the next May perfectly; in June—July the germination power decreases to 60-80%, in August to 11-30%, in September to 5-10% and in October to less than 1%. The longevity of the kernels is scarcely one year.

20. The percentage of increase in volume of boiled rice to the original volume of white rice is called "Kamabue". Kamabue of rice increases regularly with the length of time of storage. It seems as if the Kamabue and swelling ability of the water-soaked rice should go hand to hand, but both qualities are just in the contrary direction.

21. Besides, the writer studied the variations of weight of 1000 grains, taste of cooked rice, viscosity of rice paste and activities of several kinds of enzymes, during the time of storage.

22. For the storage of hulled rice it is very important to dry the grains at first, to protect it from moisture during the time of storage, to cool the grains and the granary air in summer and keep the insects in check. Air tight appartments are a good condition for the storage. In order to satisfy these conditions the situation and construction

of the granary, improvement of bags, kind of rice, method of drying must be studied further. Author.

160. Die Beziehung zwischen dem Geschlecht der Pflanzen und der Grösse, der Form, dem Gewicht und dem spezifischen Gewicht der Samen von *Cannabis sativa* L. (Japanisch mit deutscher Zusammenfassung). Mantarô KONDÔ und Tamotsu OKAMURA. (Jour. Sc. Agric. Soc. No. **233**, 1926, 233-257).

Die Pflanzen von *Cannabis sativa* werden bekanntlich in männliche und weibliche Pflanzen gesondert. Die ersteren liefern eine bessere Bastfaser als die letzteren. Wenn das Geschlecht in der reifen Frucht (Samen) bereits bestimmt ist, so ist es eine interessante und wichtige Aufgabe, die Beziehung zwischen den Eigenschaften der Samen und dem Geschlecht der Pflanzen festzustellen. Die Verfasser haben also im Jahre 1924 und 1925 die Länge, Breite, Dicke, den Formkoeffizient $\left(= \frac{\text{Länge}}{\text{Breite}} \times 100 \right)$, das Gewicht und das spezifische Gewicht jedes Kornes einzeln gemessen, jedes Korn einzeln numeriert und auf dem Felde gesät. Nach dem Aufblühen der Blüte ist das Geschlecht jeder Pflanze festgestellt worden. Die untersuchten Proben sind Totigi-Akaki und Totigi-Aoki. Die Ergebnisse sind die folgende:

1. Die Länge, die Breite, das Gewicht und der Formkoeffizient der Samen sind je nach dem Geschlecht nicht verschieden, sondern bei beiden Geschlechtern fast gleich.

2. Die durchschnittliche Dicke der männlichen Samen scheint ein wenig grösser als diejenige der weiblichen Samen, aber das ist nicht sicher.

3. Der durchschnittliche Wert des spezifischen Gewichts ist bei weiblichen Samen ein wenig grösser als bei den männlichen Samen. Aus den Samen mit dem spezifischen Gewicht von 0,86-0,92 gehen verhältnismässig mehr männliche Pflanzen hervor.

4. Abschliessend kann man sagen, dass es nicht möglich ist, durch die oben erwähnten verschiedenen Merkmale der Samen das Geschlecht der Samen festzustellen.

5. Durch Vergleichung von Akaki und Siroki hat sich herausgestellt, dass der Formkoeffizient $\left(= \frac{\text{Länge}}{\text{Breite}} \times 100 \right)$ von Siroki grösser als der von Akaki ist, was höchstwahrscheinlich auf den Unterschied zwischen den Sorten zurückzuführen ist.

6. Bei den untersuchten zwei Sorten sind die Verhältniszahlen für ♂ zu ♀ Pflanzen, wie die folgende Tabelle zeigt;

				Verhältniszahlen		
		♂ Pflanzen	♀ Pflanzen	Summe	♂ Pflanzen	♀ Pflanzen
Akaki	1924	185	225	410	100	: 122
	1925	1034	1214	2248	100	: 117
		1219	1439	2658	100	: 118
Siroki	1924	187	241	428	100	: 129
	1925	1197	1244	2441	100	: 104
		1384	1485	2869	100	: 107

Die Verhältniszahlen stimmen überein mit denen der bisherigen Mitteilungen von HEYER (100 : 116), BRIOSI (100 : 114,5) u. a., sind aber von denen von FISCHER (100 : 154) GAIN (100 : 123-194) u. a. stark verschieden.

Verf.n.

161. Ueber die schmutzigbraun gefärbten enthülsten Reiskörner "Tschamai." (Japanisch mit deutscher Zusammenfassung). Mantarô KONDÔ und Tamotsu OKAMURA. [Jour. Sc. Agr. Soc., No. **287**, 1926, 411-429].

Unter den enthülsten Reiskörnern kommen die schmutzig-braun gefärbten Reiskörner "Tschamai" sehr oft vor. Letztere besitzen geringen Wert. Bei einem Vergleiche sieht man, dass sie kleiner und leichter, im spezifischen Gewicht geringer und in der Härte grösser sind. Wenn die weissen Körnern vermischt sind, wird der Materialverlust beim Schälen viel grösser als bei den rein weissen Körnern.

Nach einer anatomischen Untersuchung der braungefärbten Körner ist die Fruchtschale braungefärbt, was die braune Färbung der Körner verursacht. Die Querzellenschicht ist besonders dunkel gefärbt. Am Querschnitt der grünreifen Reiskörner sieht man, dass die Fruchtschale, besonders die Querzellenschicht reich an Chlorophyll ist. Der braune Farbstoff der oben erwähnten braungefärbten Reiskörner kommt also höchstwahrscheinlich vom Chlorophyll her.

Bei dem braungefärbten Reiskorn ist die Kleieschicht, als ganzes genommen, dicker als bei dem weissen Korn, d.h. die äussere Schicht (die Frucht- und Samenschale) ist viel dicker, die innere Schicht (das Perisperm und die Aleuronschicht) hingegen ist dünner. Die Prozentzahl der Dicke der inneren Schicht, gemessen an der Dicke der ganzen Schicht, ist bei dem braunen Korn kleiner als bei dem weissen Korn. Diese Eigenschaften sind die Merkmale der unreifen oder schlechten Kornqualität.

Die Verfasser haben auch die Rispen analysiert und 103 Rispenbilder hergestellt. Mit Hilfe der Rispenbilder haben sie die Verteilung der braungefärbten Körner in der Rispen untersucht. Die braunen Körner sind von unten bis zur Spitze der Rispen verteilt und ihre Anzahl ist allgemeinen in den Sekundärzweigen grösser als in den Primärzweigen, und im unteren Teile der Rispen grösser als in dem oberen Teile der Rispen. Es zeigt sich auch eine starke Beziehung zwischen der Blühfolge innerhalb eines Zweiges und der Häufigkeit des braunen Kornes. Je später die Blüte aufgeht, desto häufiger ist ihr Korn braungefärbt. Ebenso zeigt sich eine positive Beziehung zwischen der Halmzahl einerseits und der Anzahl und dem Prozentsatz der braungefärbten Körner andererseits.

Die Ursache der braunen Färbung der Reiskörner dürfte eine vielfache sein. Wenn, z. B., ein Staubbeutel innerhalb des Spelzes geblieben ist, oder ein Spelz von *Helminthosporium* befallen wird, wird das Korn immer braungefärbt. Jedenfalls wird jedesmal, wenn durch irgend einen Zufall das Reifen der Körner nachteilhaft beeinflusst wird, die schmutzig braune Färbung des Kornes zum Vorschein kommen. Verf.n.

162. Ueber einige Fragen der vergleichenden Pathologie. Ernst KÜSTER. (Japan.-Deutsch. Zeitsch. f. Wiss. u. Technik 4, 1926, 35-49).

Gemeinverständliches Schrift über die vergleichende Pathologie der Tier- und Pflanzenreiche. Indem beide Reiche in vielen Hinsichten (Wachstumsmoden, Verhalten gegen die Aussenbedingungen, An- und Abwesenheit der festen Zellmembranen usw.) höchst verschieden sind, bieten beide dementsprechend in pathologischer Beziehung auch verschiedene Unterschiede. Alle diese sind an der Hand von vielen Beispielen illustriert.

163. Studies on the Falling of young Capsules of Cotton-plants. (Japanese). Sinzō MIHARA and Ryōiti YOSINAGA. (Notes from the Agric. Exp. Station Corea No. 3, 1926, 199-211).

The authors' investigations refer to the cotton-plants cultivated in Corea. Young capsules very often fall off, the separation of their stalk taking place at its joint-like insertion part of the branch bearing them. The rate of the number of falling capsules is different in different races which varies from 42,2-68,9%. The capsules which are 4-6 days old after the flowering are mostly prone to fall down, while those which are already

over one week old rarely fall down. The phenomenon is accelerated by the raining and the excessive soil moisture, and also by artificial wounding.

164. Pflanzenbiologie in Japan. Hans MOLISCH. (Japan.-deutsche Zeit. Wiss. u. Techn. **4**, 1926, 171-175).

Die Hauptabschnitte seines neuerdings in Deutschland erschienenen Buches, "Pflanzenbiologie in Japan" sind hervorgehoben. Eine kurze Zusammenfassung einiger in diesem Buche niedergelegten Tatsache, wie Meeresleuchten, Kalkbakterien, Vogelblumen usw. wird angegeben.

165. Ueber die Beziehungen zwischen dem Streckungs- und dem Dickenwachstum an den Jahrestrieben von *Pinus densiflora* und *P. Thunbergii*. (Japanisch mit deutscher Zusammenfassung). Kin'ichi MORIKAWA. (Bult. Sc. Fak. Terk., Kjuſu Imp. Univ. **1**, 1925, 291-309).

Die Wachstumserscheinungen des Jahrestriebes von *Pinus densiflora* und *P. Thunbergii* wurden sowohl durch Dimensionsmessungen als auch durch die anatomischen Beobachtungen studiert, um die korrelativen Beziehungen zwischen dem Streckungs- und Dickenwachstum nachzuweisen. Die folgenden sind einige wichtigsten Resultate davon.

Das Streckungswachstum der Knospen beginnt um Ende Februar und ist im Anfang Juli vollendet, während das Dickenwachstum derselben erst gegen Anfang März äusserlich wahrnehmbar und in Oktober vollendet ist. Die Anlage der Winterknospen wird Ende April gebildet und um ungefähr 20. Mai an der Spitze des Jahrestriebes sichtbar, wobei es hinzuzufügen ist, dass während der ganzen Bildungszeit der Winterknospen das Dickenwachstum des diesjährigen Triebes stillsteht. Wenn man das Dickenwachstum des Jahrestriebes durch die Windung des Drahtes oder das Streckungswachstum durch das Abschneiden der Spitze verhindert, so erfolgt das Unterdrücken des Streckungs- bzw. Dickenwachstums, was das Dasein einer engen korrelativen Beziehung zwischen beiden Arten Wachstums beweist.

166. Studies on the Mutations in *Oryza sativa*, I. On Staminoidal Sterile and Roll-leaved Mutants. Isaburo NAGAI. (Japan. Jour. Bot. **3**, 1926, 25-53, 5 figs.)

167. Studies on the Mutations in *Oryza sativa*, II. On Awned Sterile, Compact-paucicled and Dwarf Mutants. Isaburo NAGAI. (Japan. Jour. Bot. **3**, 1926, 55-66, 2 figs.)

168. Studies on the Mutations in *Oryza sativa*, III. On Paleaceous Sterile Mutant. Isaburo NAGAI. (Japan. Jour. Bot. **3**, 1926, 67-84, 5 figs.)

169. Studies on the Mutations in *Oryza sativa*, IV. On a Case of Partial Sterility. Isaburo NAGAI. (Japan. Jour. Bot. **3**, 1926, 85-96).

170. Notes on Japanese Ferns III. Takenoshin NAKAI. (Bot. Mag. Tokyo **40**, 1926, 239-275).

This is a revision of *Hymenophyllaceae* of Japanese Empire. First, the author cleared up the names and synonyms of family and genera. Then, he subdivided the genera into sections and arranged the sectional names and their synonyms. He made analytical keys when the genera have many sections and sections have many species. Specific names and synonyms were also arranged with reference to all literatures he could obtain. The following are the principal contributions.

Hymenophyllum sect. *Ptychophyllum*, comb. nov.

H. sect. *Acanthotheca*, sect. nov.

H. sect. *Hymenoglossum*, comb. nov.

H. crispatum WALLICH, new to the Flora of Japan.

H. coreanum NAKAI, new species found in Korea.

H. fujisanensis NAKAI, a new species found in Japan.

Trichomanes sect. *Abrodictyum* NAKAI, comb. nov.

T. sect. *Crepidium* NAKAI, comb. nov.

T. Prestianum NAKAI, a new name applied to *T. millefolium* PRESL (not DESVAUX)

T. bonincolum NAKAI, a new species found in Bonins.

T. sect. *Protocephalomanes* NAKAI, sect. nov.

T. sect. *Trichomanoides* NAKAI, sect. nov.

T. longifrons NAKAI, a new species found in Formosa.

T. Somai NAKAI, a new species found in Formosa.

T. nipponicum NAKAI, a new species found in Japan.

The following transference was made:

Hymenophyllum crispato-alatum HAYATA to *H. javanicum* SPRENGEL.

H. parallelocarpum HAYATA to *H. Blumeianum* SPRENGEL.

H. constrictum HAYATA & *H. punctisorum* ROSENSTOCK to *H. integrum* V. D. BOSCH.

Trichomanes palmifolium HAYATA to *T. Makinoi* CHRISTENSEN.

T. acuto-obtusum HAYATA to *T. bipunctatum* POIRET.

T. cupressifolium HAYATA to *T. pyxidiferum* L.

T. kalomocarpum HAYATA to *T. orientale* CHRISTENSEN.

Author.

171. Notes on Japanese Ferns IV. Takenoshin NAKAI. (Bot. Mag. Tokyo **40**, 1926, 371-396).

This paper contains a new classification of Japanese *Ophioglossaceæ* and a critical note on the genus *Drymoglossum*. The author classified Japanese *Ophioglossaceæ* into 4 genera which contain 17 species. He made also the analytical keys of all species.

After seeing all the ferns described under *Drymoglossum* except 3 species of South Africa, Madagascar and Martinique Island the author has come to the conclusion that there are 5 species of *Drymoglossum* in Asia and given their synonyms and habitats.

172. Notulæ ad Plantas Japoniæ & Koreæ XXXI. Takenoshin NAKAI. (Bot. Mag. Tokyo **40**, 1926, 161-171.)

The publication of the results of the author's studies on Japanese and Korean plants had been discontinued on account of his being abroad for a couple of years. The present work is partly based upon his studies of many type-specimens of East Asiatic plants in European and American herbariums.

1. *Juniperus coreana* NAKAI, a new species found in Korea.
2. *Carpinus Turczaninowii* HANCE, new to the Flora of Korea.
3. *Carpinus coreana* NAKAI, a new species found in Korea.
4. *Carpinus coreana* var. *major* NAKAI, a new variety found in Korea.
5. *Betula Ermani* var. *ganjuensis* NAKAI, a new variety found both in Japan and Korea.
6. *Quercus mongolico-dentata* NAKAI, a new natural hybrid found in Korea.
7. *Quercus dentato-mongolica* NAKAI, a new natural hybrid found in Korea.
8. *Quercus serrata* THUNBERG.

This name has been erroneously applied before for *Quercus variabilis* BLUME or

sometimes for *Quercus acutissima* CARRUTHERS. But the author found that it is the older valid name of *Quercus glandulifera* BLUME when he saw the type-specimens of THUNBERG, and thus the following new combinations were made.

Quercus serrata var. *brevipetiolata* for *Q. urticæfolia* var. *brevipetiolata* DC.

Quercus serrata var. *glanduligera* for *Q. Griffithii* var. *glanduligera* FRANCHET.

9. *Celtis jessoensis* KOIDZUMI, Korea and Japan.

The author made the distinction of *Celtis jessoensis* and *Celtis Bungeana*.

10. *Celtis koraiensis* var. *holophylla* NAKAI, a new variety found in Korea.

11. *Celtis Leveillei* var. *heterophylla* NAKAI, new to the Flora of the Island Tsusima.

12. *Celtis cordifolia* NAKAI, a new species found in Korea.

13. *Morus mongolica* SCHNEIDER, new to the Flora of Korea.

14. *Morus tiliaefolia* MAKINO, new to the Flora of Korea.

15. *Stephanandra quadrifissa* NAKAI, a new species found in Korea.

16. *Lespedeza macrocarpa* BUNGE, new to the Flora of Korea.

17. *Abelia mosanensis* CHUNG, a new species found in Korea. Author.

173. Notulæ ad Plantas Japoniæ & Koreæ XXXII. Takenoshin NAKAI. (Bot. Mag. Tokyo **40**, 1926, 463-495.)

This paper contains a collection of new facts which the author found both in Europe and America, and also a collection of new plants.

1. *Astilbe chinensis* var. *typica* FRANCHET, new to the Flora of Japan.

2. *Astilbe chinensis* var. *Davidii* FRANCHET, new to the Flora of Japan.

3. *Astilbe chinensis* var. *divaricata* NAKAI, a new variety found in Korea.

4. *Astilbe senanensis* MATSUMURA as the synonym of *A. odontophylla* MIQUEL.

5. *Astilbe fujisanensis* NAKAI, a new species found in Japan.

6. *Astilbe microphylla* var. *intermedia* NAKAI, a new variety found in Japan.

7. *Astilbe shikokiana* NAKAI, a new species found in Japan.

8. *Hydrangea paniculata* var. *depressa* NAKAI, a new variety found in Japan.

9. *H. paniculata* var. *vegeta* NAKAI, a new variety found in Japan.

10. *Parnassia palustris* var. *tenuis* WAHLENBERG as the older valid name of *Parnassia palustris* var. *alpina* DRUDE.

11. *Parnassia japonica* NAKAI, a new species found in Japan.

12. *Forsythia koreana* NAKAI, a new species found in Korea.

13. *Sambucus Sieboldiana* var. *major* NAKAI, a new variety found in Japan.

14. *S. Sieboldiana* var. *latifolia* NAKAI, a new variety found in Japan.

15. *S. Buergeriana* var. *lacera* NAKAI, a new variety found in Japan.

16. *S. Buergeriana* var. *lasiocarpa* NAKAI, a new variety found in Korea.

17. *S. Buergeriana* var. *aurantiaca* NAKAI, a new variety found in Japan.

18. *S. Williamsii* HANCE, new to the Flora of Korea.

19. *S. barbinervis* NAKAI, a new species found in Amur.

20. *S. sibirica* NAKAI, a new species found in Siberia.

21. *S. velutina* NAKAI, a new species found in Korea.

22. *S. glabrescens* NAKAI, a new species found in Quelpaert.

23. *Oldenlandia crassifolia* DC for the Japanese *O. paniculata*.

24. *Vaccinium boninense* NAKAI, a new species found in Bonins.

25. *V. shikokianum* NAKAI, a new species found in Shikoku.

26. *V. Chamissonis* BONGARD for *V. ovalifolium* of Yezo and Amur.

27. *Rhododendron lagopus* NAKAI, a new species found in Japan.

28. *Rhododendron nudipes* NAKAI, a new species found in Japan.

29. *Rhododendron nagasakianum* NAKAI, a new species found in Japan.
30. *Tripetaleia yakusimensis* NAKAI, a new species found in the island Yakushima.
31. *Rhododendron reticulatum* var. *ciliatum* NAKAI, a new variety found in Japan.
32. *Rhododendron Weyrichii* var. *psilostylum* NAKAI, a new variety found in Quel-
paert.
33. *Premna microphylla* var. *glabra* NAKAI, a new variety found in China.
34. *Premna subcordata* NAKAI, a new species found in China.
35. *Calamagrostis Langsdorfii* TRINIUS for *C. villosa* of East Asia.
36. *C. subacrochaeta* NAKAI, a new species found in Korea.
37. *C. paishanensis* NAKAI, a new species found in Korea.
38. *Callicarpa japonica* var. *microcarpa* NAKAI, a new variety found in Japan.
39. *Celastrus strigosus* NAKAI, a new species found in Japan.
40. *Euonymus nikoenensis* NAKAI, a new species found in Japan.
41. *Euonymus Sieboldianus* var. *sanguineus* NAKAI, a new variety found in Japan.
42. *Euonymus dorsicostatus* NAKAI, a new species found in Japan.
43. *Akebia trifoliata* var. *clematifolia* NAKAI, comb. nov. Author.

174. *Notulæ ad Plantas Japoniæ & Koreæ XXXIII.* Takenoshin NAKAI.
(Bot. Mag. Tokyo 40, 1926, 563-586).

This contains following plants.

1. *Juglans stenocarpa* MAXIMOWICZ, new to the Flora of Japan.
2. *Deutzia subvelutina* NAKAI, a new species found in Japan.
3. *Deutzia Zentaroana* NAKAI, a new species found in Japan.
4. *Pyrus pyrifolia* NAKAI, comb. nov.

The author happened to find that the Japanese pear, *Taihei* was described under the name of *Ficus pyrifolia* by BURMANN, when he saw the type-specimens in the "Herbier" DELESSERT. Hence the above combination.

5. *Rosa Luciae* FRANCHET et ROCHEBRUNNE.

The author saw the type-specimens and found that *Rosa pulcherrima* KOIDZUMI corresponds to this species.

6. *Rosa multiflora* THUNBERG.
7. *Rosa polyantha* SIEBOLD et ZUCCARINI.

The author saw the type-specimens of THUNBERG and found that the *Rosa multiflora* is not *Rosa polyantha*, but the older name of *Rosa fujisanensis* MAKINO.

8. *Rosa Uchiyamana* MAKINO.

The study of the type-specimens has shown the author that *Rosa multiflora* var. *trichogyna* FRANCHET et SAVATIER and *Rosa multiflora* var. *cathayensis* REHDER et WILSON correspond to *Rosa Uchiyamana*.

9. *Rosa Wichuraiana* CRÉPIN.

The author found that the roses called *Rosa Luciae* by Japanese botanists, and *Rosa polita* and *Rosa diversifolia* of CARDOT are *Rosa Wichuraiana*.

10. *Ilex crenata* var. *hachijyoensis* NAKAI, a new variety found in the Island Hachijyo.
11. *Euonymus Maackii* RUPRECHT, new to the Flora of Japan.
12. *Meisteria longiloba* NAKAI, a new species found in Japan.
13. *Ixeris japonica* NAKAI, comb. nov.

The author found that BURMANN's *Lapsana japonica* is the oldest name of *Ixeris debilis*, hence the above combination.

14. *Taraxacum longe-appendiculatum* NAKAI, a new species found in Japan.
15. *Aster leiophyllus* FRANCHET et SAVATIER.

The author saw the type-specimen and found that all Japanese botanists have mistaken this for other species.

16. *Cnicus Reini* FRANCHET et SAVATIER.

17. *Cnicus Hilgendorffii* FRANCHET et SAVATIER.

Having seen the type-specimens, the author found that the former is the *Cirsium* erroneously known as *Cirsium Hilgendorffii* MAKINO, and the latter is the synonym of *Cirsium pendulum* FISCHER.

18. *Ligularia polycephala* NAKAI, a new species found in China.

19. *Quercus paucidentata* FRANCHET.

The author found that the oak generally known as *Quercus sessilifolia* differs from *Q. sessilifolia* of BLUME. He adopted the name *Q. paucidentata* for the oak, according to A. FRANCHET on a specimen of Paris Museum. Besides these he saw the type-specimens of *Ligularia sibirica* var. *oligantha* MIQUEL, *Quercus glabra* THUNBERG, *Quercus thalassica* HANCE, *Q. inversa* LINDLEY, *Q. bambusæfolia* HANCE, *Q. bambusifolia* FORTUNE, *Q. glauca* var. *stenophylla* BLUME, and he pointed out general misunderstandings, and corrected out their names.

20. *Ligularia intermedia* var. *stenopetala* NAKAI, a new variety found in Korea.

21. *L. intermedia* var. *venusta* NAKAI, a new variety found in Mongolia.

22. *Quercus stenophylla* var. *angustata* NAKAI, a new variety found in Japan.

23. *Acer monocarpon* NAKAI.

24. *Acer horonaiense* NAKAI.

The author found these two new species from Yezo in the Herbarium of Paris Museum.

25. *Castanea Bungeana* BLUME.

Having seen the type-specimen the author found that the common Chinese chestnut in market belongs to this species, not *Castanea mollissima* BLUME. *Castanea Duclouxii* DODE and *C. formosana* HAYATA are the synonyms of *C. Bungeana*. Author.

175. On the Spot-leaf Disease of Callistephus chinensis. (Japanese). Hisao NAKAMURA. (Jour. Plant Protection 13, 1926, 8 pp., 1 pl.)

Septoria callistephi GLOYER, a causal organism of the "spot-leaf disease" of *Callistephus chinensis* was discovered in Japan. Its behaviour in nutrient media under different temperatures is given.

176. On Sclerotium Rolfsii Sacc. III. (Japanese with English résumé). Kaku-goro NAKATA. (Bult. Sc. Fak. Terk., Kjušu Imp. Univ. 2, 1926, 7-19, 2 figs.)

The spores of *Sclerotium Rolfsii* have never yet been observed, except by K. SAWADA, who, on the basis of his observations, considers not only *Hypochnus centrifugus*, but also *H. Solani* and *H. Cucumeris* as its spore-stage.

The author who has obtained 33 strains of *S. Rolfsii* from various countries, viz. Japan, Corea, United States of America, West Indies, Java, Philippine Isl., etc. was able to discover the spores in three strains, two from Japan and one from America. On account of such observations he considers that *H. centrifugus* is the perfect form of *S. Rolfsii*; it is however different from *H. Solani* which is in its turn referable to *Rhizoctonia Solani*. *H. Cucumeris* is not referable to *H. centrifugus*, but to *H. Solani*. *S. coffeicolum* STAHEL is to be regarded as a strain of *S. Rolfsii*.

177. Contributions to the Knowledge of Abscission and Exfoliation of Floral Organs. Isawo NAMIKAWA. (Journ. Coll. Agr. Hokkaido Imper. Univ. 17, 1926, 63-131.)

The term abscission is understood to mean the amputation of an organ by means of isolation of living cells, while exfoliation means the falling off of an organ, preceded by its drying and death and accomplished by mechanical rupture of the dead tissue. Based on the anatomical changes at the base of the organ, the writer classified the type of the shedding of floral organs and catkins as follows: (1) abscission, (2) exfoliation: *a*, ligno-suberization of a more or less differentiated cell-layer, *b*, lignification, *c*, mucilaginous change and (3) no change in the floral organ which is eventually shed together with the shoot from the base or some portion of the latter.

At the base of the catkin stalk, a more or less differentiated separation zone is observed. In the zone well differentiated, the cells are small, isodiametric and rich in protoplasm, and the mechanical cells such as bast fibres or stone cells are nearly or completely lacking. In *Alnus*, *Salix*, *Populus* and *Castanea*, a constriction is seen in this zone. A separation layer is formed in this zone and a separation process takes place, being brought about by the dissolution of the middle lamellae of cell walls, rapid growth of cells and an increase in their osmotic pressure. The mechanical cells in the vascular bundles are broken quite mechanically after the separation process has proceeded to a certain degree. Plasma contents, starch grains and oil droplets usually increase in the separation layer before the separation. Accompanying the separation process, cell division takes place in the separation zone in *Salix* and *Castanea*, but never in the catkins of other genera studied. Abscission takes place in all the catkins examined, except the fertilized female catkin of *Alnus*. The male flower of *Cucumis sativus* is shed by the normal separation process, while the female flower and the stalk of the male flower in the same plant are not shed in this way.

The mode of exfoliation of the floral organs in *Narcissus*, *Lycoris*, *Menyanthes* and *Ribes* belongs to the type *a*. The female flower in *Cucumis sativus* also exfoliates by this method. The perigone and style of *Hosta japonica* and the corolla, filament and style of *Platycodon grandiflorum* show exfoliation of the type *b*. The only example of the type *c* met with was the perigone of *Iris setosa*. After the abscission or exfoliation, the tracheidal elements in the scar or in the tissue which undergoes the change, are stopped with wood gum. Tylosis is scarcely seen. The floral organs of *Gagea*, *Trillium* and the fertilized female catkin of *Alnus* show the mode 3.

Variation in the osmotic pressure in the organ to be shed was measured by means of plasmolytic method. The osmotic pressure of the catkin stalk and separation zone of young catkins in *Alnus japonica* increases until towards the flowering time. In young catkins of species of *Alnus*, the osmotic pressure in the cortex of the separation zone is lower than in the corresponding part of the cortex of the catkin stalk. Generally speaking, the osmotic value is higher in the outer tissue of the catkin axis and in the floral organs than in the inner tissue and in the catkin axis respectively. At the time of separation, the pressure in the floral organ and catkin axis decreases conspicuously. The osmotic pressure in the separation zone and separation cells becomes remarkably high before the separation.

Two types of osmotic fluctuation are seen in the petals and perigones in different plants: (1) the pressure becomes simply lower during the development of the floral leaves and (2) the pressure decreases before flowering, becomes increased rapidly at the time of the first opening of the flower and then shows a final decrease. In general, the osmotic value in the floral leaf at the stage of young flower bud is higher than in the older ones. *Corydalis*, *Pharbitis* and *Hosta* undergo the change of the first type; the petals of *Adonis*, *Gagea*, *Prunus*, *Lilium* and the bracts of *Bougainvillea* show the

fluctuation belonging to the second type. Such a fluctuation is in close relation with the rate of growth and the variation in dry weight of the organ. The period of the rapid rise of the osmotic pressure at the first opening of the flower coincides with the rapid increase of dry weight and of the vigorous growth of the petal. The growth of the petal becomes very slow after the flower has opened. The dry weight decreases together with the osmotic pressure before defloration. Author.

178. Studies on the Rice Blast Disease. (Japanese). Yosikazu NISIKADO. (Byôkin-Gaityû Ihô, or Bull. Plant Protection, issued from the Bureau of Agric., Dept. Agric. Forest. No. 15, 1926, II+211 pp.) See this No., p. 239-244.

179. Determination of Hydrogen-Ion Concentration and its Application to the Studies of Plant Diseases. (Japanese). Yosikazu NISIKADO. (Agric. Studies 9, 1926, 50-112).

Introductory conceptions of hydrogen-ion concentration are briefly interpreted. Methods of the colorimetric determination of hydrogen-ion concentration after CLARK and LUBS, somewhat simplified by the writer, are described. Adjustment of reaction of nutrient bouillon by the methods of determination of pH, comparisons of pH values and the FULLER's scales of culture media, hydrogen-ion concentration and titration curves of rice decoction and other culture media are described at some length.

Effects of hydrogen-ion concentration on the growth and the pathogenicity of *Helminthosporium Oryzae* were studied. The conidia germination took place between pH 2.6 and 10.9, and the germ-tubes and the fungus colonies grew best at pH 6.6-7.4. The conidia were produced at pH 4.0-10.0, and the production was better in alkaline media than in acid. In alkaline media the conidiophores were produced more copiously and much shorter than in acid media. The conidia produced in acid media were greenish and in alkaline media they were brownish, while the size of the conidia seemed to show no great variation with the pH values of the media. There was very slight relation between the pH values of the infection drops and the penetration of the infection hyphae of *Helm. Oryzae* into the host tissues. In number and in size, the lesions of *Helm. Oryzae* on leaves of rice grown in sand culture of acid reaction were much greater than on those of alkaline reaction. The occurrence of the helminthosporiose on rice plant grown in fields of acid soils seems to be severer than in those of alkaline soils. Author.

180. On the Variation of Temperature according to the Locations in an Incubator. (Japanese). Yosikazu NISIKADO. (Journal of Plant Protection, 13, 1926, 605-611.)

Experiments were undertaken by the writer on the variation of temperature according to the places in an incubator. The experiments were carried out with a FRIES-incubator made in U. S. A., which is generally known as one of the best incubators in the world. Variation of temperature readings of a certain place in the incubator was less than 0.5°C., and the line of a thermograph located in a place in the incubator runs almost straight. And it may be considered as a constant temperature in usual culture works. According to the writer's experiments, however, there was a great divergence in temperatures according to the places in the incubator.

In a FRIES-incubator set at 35°C., the readings were taken from a thermometer suspended in the center of the incubator. Three agar plates were piled up, and rod thermometers placed on the surface of the lower and the upper plates. The temperature readings of the thermometer on the lower plates were about 3°C. higher than on those of the upper

plates. In the other experiments, difference of temperatures of the agar in the culture plates were determined by a thermocouple and a REEDS and NORTHRUP potentiometer. Seven agar plates were piled up in the incubator set at 35°C., and the two ends of the thermocouple were inserted into the agar medium in the uppermost and the lowermost plates. From the potentiometer readings the difference of temperatures of the agar media of the both plates were calculated. The difference of the temperatures was 2-2.4°C. These variations of temperatures may give no great effects on the fungus growth in the cases of cultures near or below the optimum temperature. On the contrary, in the cultures near maximum temperature for the growth, these variations will exercise a great influence on the rate of growth and other characteristics.

To remove the variation of temperatures according to the places in an incubator, many devices were tried by the writer, but it was in vain so far. Changing the place of the cultures in an incubator vertically and horizontally, seems to be one of the best methods to remove the effect of the temperature variation on the growth of the cultures.

Author.

181. Studies on two Helminthosporium Diseases of Maize caused by Helminthosporium turcicum Passer. and Helminthosporium Maydis n. sp. (Japanese). Yosikazu NISIKADO. (The Scientific Researches of the Alumni Association of the Morioka Agricultural College, **3**, 1926, 35-71). S. Japan. Jour. Bot. **3**, 1926, (35), Abstract 105.

182. Studies on two Helminthosporium Diseases of Maize, caused by Helminthosporium turcicum Passer. and Ophiobolus heterostrophus Drechsler (Helm. Maydis Nisik. et Miyake.) Yosikazu NISIKADO and Chûichi MIYAKE. (Berichte d. Ôhara Inst. f. landwirtschaftl. Forschungen, **3**, 1926, 221-266, 6 pls.) S. Japan. Jour. Bot. **3**, 1926, (35), Abstract 105.

183. The pungent Principles of Ginger Pt. III. Contribution on Shogaol. Hiroshi NOMURA and Shunji TSURUMI. (Proc. Imp. Acad. **2**, 1926, 229-232).

184. On a Disease of Soybean Pods due to the Parasitism of a Fusarium Fungus. (Japanese). Tomoo NOZIMA. (Jour. Plant Protection **13**, 1926, 10 pp., 1 pl).

This fungus produces on the pods of soybean numerous salmon-colored minute spots, or white to rose-colored hyphae, so that the growth of seeds is checked. The infection takes place chiefly through wounds. It grows well in various nutrient media, except in the water extract of corn powder and agar containing this extract, where the growth is very poor. It is not probable that it is able to infect the roots of soybean.

185. On the Structure of the Japanese Species of Cyathea. (Japanese with an English résumé). Yudzuru OGURA. (Bot. Mag. Tôkyô **40**, 1926, 307-310).

Only one species of *Cyathea*—*C. spinulosa*, WALL.—is known in Japan. The stems of this species collected in different places show the remarkable structural differences in the form of meristemes, in the outline of sclerenchymatous sheaths and in the presence or absence of cortical bundles. These different characters are connected by intermediate types, and can not be considered as the specific differences. The species from Formosa however, shows a somewhat different construction in the form of meristemes, and seems to be a different species or variety.

Author.

186. On the Structure and Affinity of Cibotium Barometz, Sm. (Japanese)
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with an English résumé). Yudzuru OGURA. (Bot. Mag. Tôkyô 40, 1926, 349-359, 4 figs.)

Cibotium Barometz has a creeping rhizome densely covered by golden filiform hairs. The stem stele is a dictyostele or solenostele, and the stelar margin at the leaf-gap curves outwards in a peculiar manner. The leaf-trace is detached from the stele as a single heart-shaped band, which is divided into numerous strands at the base of the petiole. At the base of the petiole, numerous strands are arranged in a peculiar manner, as those of *Alsophila* and *Cyathea*, but at the upper part of the petiole, they are connected into a single band. The sclerenchymatous sheath on both sides of the stele, one of the characteristics of the Cyatheacean stem, is not present. Adventitious buds are often found.

Though the general features of this species show the Cyatheacean type, the creeping nature of the stem, the absence of the sclerenchymatous sheath of the stem stele and the presence of filiform hairs instead of scaly ones distinguish it from other Cyatheacean species. Author.

187. On the Structure of the Species of *Alsophila* found in Formosa and Loochoo. (Japanese with an English résumé). Yudzuru OGURA. (Bot. Mag. Tôkyô 40, 1926, 401-417, 7 figs.)

The internal structure of three species of *Alsophila* collected in Formosa and Loochoo is described. In external feature and internal structure *Al. latebrosa* (?) is similar to *Al. Bongardiana*, *Al. podophylla* to *Al. Ogurae*, and *Al. formosana* to *Al. acaulis*.

On the external side of the stem stele, longitudinally and tangentially elongated cells are arranged in one layer.

The stelar base of the adventitious bud found on the stem of *Al. podophylla* and *Al. formosana* has no communication with the stele of the stem, and is enclosed within the hypodermal layer of the latter. Author.

188. Zur Kenntnis fossiler Koniferenhölzer aus Japan. Kametaro OHARA. (Japan. Jour. Bot. 3, 1926, 97-109, 1 Taf.)

189. Embryologische Studien an *Heloniopsis breviscapa*. Tomowo ONO. (The Sc. Rpts. Tôhoku Imp. Univ. 4th Ser. 2, 1926, 93-104, 5 Textfig.)

Bei *Heloniopsis breviscapa* geht die Embryosackentwicklung, entgegen den meisten anderen Liliaceen, ganz normal vor sich. Die Doppelbefruchtung kommt vor. Die haploide Chromosomenzahl beträgt 17, während bei der Endosperm bildung die triploide Zahl 51 beobachtet wurde. Die Embryoentwicklung geht in früheren Stadien ganz regelmässig vor, was unter den Liliaceen eine Ausnahme ist. Die Endosperm bildung ist vom sog. Helobiæ-Typus: nach der ersten Teilung des primären Endospermkerns wird der Embryosack in zwei ungleiche Kammern geteilt, zwischen denen eine Scheidewandbildung ausbleibt; die Vielzellbildung kommt erst später gleichzeitig bei zwei Kammern vor.

190. Grössenverhältnis der Geschlechtschromosomen von *Rumex Acetosa* L. Tomowo ONO. (Sc. Rpts. Tôhoku Imp. Univ. IV. Ser., 2, 1926, 159-160, 6 Abbild.)

Bei der heterotypischen Kernteilung von *Rumex Acetosa* and *thyrsoflorus* beobachtet man ein eigentümliches dreiteiliges Chromosom, welches aus einem X-Chromosom und zwei kleineren Y-Chromosomen besteht. Als die Gesamtmenge von zwei Y-Chromosomen grösser als das X-Chromosom zu sein aussieht, hat der Verf. mittels einer eigentümlichen

Methode die Messung b. *R. Acetosa* gemacht. Er hat dabei die soeben genannte Tatsache bestätigen können: die Fläche des X-Chromosoms and die Gesamtfläche von zwei Y-Chromosomen betragen im Durchschnitte 105,5 resp. 146,8 cm^2 .

191. Preliminary Report on the Primary Growth of Rice-seedlings. (Japanese with English résumé). Wataru SADAMOTO. (Jour. Sc. Agric. Soc., No. 236, 1926, 12 figs.)

In the rice-seedlings growing under shallow water, about 3 mm for instance, the plumule grows with a normal and uniform velocity. But in those growing under deep water, 20-30 mm, the plumule grows very quickly at first, but when its tip emerges from water, its growth becomes so slow that it nearly stops, though little later it begins to go on again normally.

192. Ueber die experimentell veranlasste Entstehung von keimfähigen Pollenkörnern mit abweichenden Chromosomenzahlen. Tetsu SAKAMURA und Isamu STOW. (Bot. Mag. Tôkyô 40, 1926, 11-137, 1 Taf. u. 122 Textfig.)

193. On *Oryza minuta* Presl. and its Relation to Cultivated Varieties of Rice. (Japanese with English résumé). Takashi SASAKI. (Jour. Sc. Agric. Soc., No. 281, 1926, 141-154, 3 figs.)

Oryza minuta is a wild species growing in the Philippine Isl., Borneo, etc. which was first described by PRESL. According to CARLETON (1920) small-kerneled Japanese varieties, Sinriki, Wataribune, and Omati ought to belong to the *minuta* species. In *O. minuta* the caryopsis measures 4 mm long, while in *O. communis* (large-kerneled) it is 5-7 mm long, so that the three varieties above mentioned of which the caryopsis is longer than 5 mm should properly belong to the latter species. Besides, the careful comparison of PRESL's original type specimen of *O. minuta* in Prague has shown the author that between this species on one hand and the three varieties on the other there are several distinguishing characteristics. The author's conclusion is therefore that the opinion of CARLETON is not founded.

194. Ein Beispiel der unabhängigen Vererbung der Grannen- und Spelzenspitzenfarbe bei Reis. (Japanisch). Hiromiti SUGI und Yaitirô KITAGAWA. (Notes from the Agric. Exp. Station Corea, No. 5, 1926, 411-414).

Bei den bisher eingehend studierten japanischen Reissippen stimmen die Grannen- und die Spelzenspitzenfarbe immer zueinander überein, purpurn, rot, gelb usw. Nun bei einigen koreanischen Sippen ist es etwas anders. 1914 haben die Verf. n einen spontanen F_1 -Bastard bekommen, welcher im nächsten Jahre zu den F_2 -Individuen mit roten Spelzenspitzen und Grannen, denjenigen mit roten Sp. und farblosen Gr. und denjenigen mit farblosen Sp. und Gr. im Verhältnisse 9 : 3 : 4 aufgespalten ist. Dies Verhalten kann man durch die Annahme von zwei Faktoren *A* und *B* erklären, von denen der erstere bloss die Spelzenspitze, und der letztere zusammen mit *A* die Granne rot machen kann. Die Annahme wurde durch die F_3 -Kultur bestätigt.

195. Kopulationserscheinungen bei der Sporenkeimung der *Saccharomyces*-arten II. Mit besonderer Berücksichtigung auf die Kopulation an den Sakéhefen und einigen anderen Hefearten. (Japanisch). Kinsi SUMINOE. (Jour. Sc. Agric. Soc. Nr. 285, 1926, 323-334, 23 Fig.)

1. Niemand hat bisher die Kopulation bei den Sakéhefen beobachtet. Es ist jedoch dem Verf. gelungen, an vielen Rassen derselben diese Erscheinung wahrzunehmen.

Merkwürdig ist es dabei, dass in einem Falle zwei zur Kopulation gelangenden Konidien an ihrer Grösse verschieden sind und die kleinere davon bald nachher zu Grunde geht. Hinzufügen möchte der Verf., dass bei einer Rasse des amerikanischen Weines (BRUCKS III) die ganz gleiche Erscheinung beobachtet werden konnte.

2. Dass es bei *Saccharomyces cerevisiae* überhaupt keine Kopulation gibt, wurde von MARCHAND betont. Bei einer untergährigen Bierhefe (Saaz) konnte aber der Verf. diese Erscheinung wirklich beobachten.

3. Die Kopulation konnte ausserdem bei den folgenden Hefen wahrgenommen werden: *S. Schaushing* 1, 9 Rassen des amerikanischen Weines, dieselben des japanischen Weines, Hefe des Champagneweines, und Logos Hefe (*S. brasiliensis*).

Auf Grunde seiner Beobachtungen, welche auf einer grossen Anzahl der Hefenrassen begründet sind, scheint es dem Verf. nicht unwahrscheinlich zu sein, dass die Kopulationserscheinung sehr weit, ja sogar bei der ganzen *Saccharomyces*-Gattung verbreitet sein wird. Verf.

196. Chromosompolyploidie bei Aster und dessen verwandten Gattungen. (Japanisch mit deutschem Résumé). Masato TAHARA und Naomasa SHIMOTOMAI. (Bot. Mag. Tôkyô 40, 1926, 132-136, mit 12 Fig.)

Chromosompolyploidie kommt bei der Gattung *Aster* und dessen verwandten Gattungen vor. Haploidechromosomenzahl beträgt bei *Callistephus chinensis*, *Asteromoea indica*, *A. i.* var. *pinnatifida*, *Asteromoea Savatieri*, *Aster Glehni*, *A. fastigiata*, *A. scaber*, *A. viscidulus*, *A. Tripolium* 9, bei *Aster trinervius* var. *genuinus*, *A. t.* var. *adustus* 18 und bei *Aster tataricus* 27. Chromosomdimension ist am grössten bei *Aster Tripolium* und am kleinsten bei *Asteromoea indica* var. *pinnatifida*. Die Gestalt der Doppelchromosomen bei der heterotypischen Metaphase ist sehr verschieden.

Verf.n.

197. On the Frequency of the spontaneous Hybridization in Soy-bean. (Japanese). Mikio TAKAGI. (Notes from the Agric. Exp. Station Corea, No. 4, 1926, 323-324).

The experiments were carried on in Corea by planting a Soy-bean race with blue endosperm and another with yellow one very near together. As the yellow and the blue endosperm colour are dominant and recessive respectively, and the phenomenon of *xenia* takes place here, it is naturally possible to recognize on the recessive parent itself, whether the crossing by the dominant parent has taken place. The author's results are as follows: the spontaneous cross has taken place in 52 out of 148 plants of the blue race; the number of grains produced by the cross amounts pro individual in general to 1-2%, and in one exceptional case to more than 8%. Of 13388 grains harvested by the author 83 were found to be the cross-products, i. e. 0.62%.

198. On the Germinating Power of Wheat and Barley Grains harvested at various Stages of their Development, and on the Influence of such Grains towards the next Generation. (Japanese). Tatzô TAKASAKI. (Notes from the Agric. Exp. Station Corea, No. 2, 109-123).

Barley grains collected earlier than the 17th day after the appearance of the spike show very low germinating power, and require long time for germination, while those collected after the 26th day do not at all differ in both respects from wholly ripe ones. So it is also with wheat grains which are collected even earlier, soon after the 17th day.

As to the influence of early harvest of grains towards the next generation the author found that in barley and wheat the grains collected after the 14th and the 17th day

respectively give rise to the plants as high as those produced by wholly ripe grains, and further the grains collected after the 17th and the 29th day respectively give rise to those which may develop as many shoots as those grown from the ripe grains.

198. On the Flowering and the Pod-formation in Soy-bean. (Japanese). TATUZÔ TAKASAKI. (Notes from the Agric. Exp. Station Corea, No. 4, 1926, 307-322).

In each plant of Soy-bean flowers are produced most early at the 1st-4th branch, and in each branch at the 1st-4th internode. The percentage of the number of capsules which come to ripening were found to be 49,30 in one race and 43,52 in another, in average 46,41.

199. A new Species of Citrus from Formosa. Tyôzaburô TANAKA. (Proc. Imp. Acad. 2, 1926, 345-347).

A detailed description of a new species, *Citrus taiwanica* TANAKA et SHIMADA.

200. Comparative Studies on the Physiology of Fusarium Lini and Colletotrichum Lini. Yoshihiko TOCHINAI. (Journ. Coll. Agric. Hokkaido Imp. Univ. 14, 1926, 171-236.)

Wilt-disease and anthracnose attack the flax plant most virulently at its seedling stage in Hokkaido. The wilt-disease of flax is caused by a well known fungus, *Fusarium Lini* BOLLEY. To the causal fungus of flax-anthracnose different names have been given by several authors, but the fungus should be called *Colletotrichum Lini* (WESTERDIJK) TOCHINAI.

In the present paper, the author has dwelt upon the pathological explanation of the wilting of affected seedlings concerning some physiological characters of the causal fungi.

The culture studies on their nutrition were carried out about carbon and nitrogen sources. The carbohydrates (glucose, fructose, galactose, maltose, sucrose, lactose, soluble starch, inuline and glycogen) were generally well suited as carbon sources, and higher alcohols also seemed to be nutritious for the fungi. Especially mannite was very nutritious for *Fusarium Lini* no less than sugars. Comparing the nitrogenous nutrition, on the whole, the organic compounds were more suitable than the inorganic ones. In the latter, nitrogen in ammonium form was more easily assimilable than that in nitrate form, while nitrite was entirely unsuitable for both fungi. Amino-acids (glycocoll, leucine, glutamic acid and asparagine) were generally suitable as nitrogen source, and the mixed use of several kinds of them was highly nutritious for the fungi. The proteins (albumin, casein, gelatine and mucin) were generally nutritious for the fungi, but they were not so easily assimilable as peptone, probably due to the stable construction of their molecules.

The H-ion concentration of the culture medium played an important role on the development of the fungi. *Fusarium Lini* was capable of growing in a wider range of it than *Colletotrichum Lini*. The optimum H-ion concentration for the mycelial growth of the former fungus was about pH 5 and for that of the latter fungus was about pH 6. *Fusarium Lini* decreased the H-ion concentration of culture solution when its initial H-ion concentration was higher than about pH 6.5, and it was very remarkable in the solution containing organic nitrogen compounds. Such the stale culture solution often showed fairly strong alkaline reaction. *Colletotrichum Lini*, however, did not decrease the H-ion concentration of the solution when its initial H-ion concentration was lower than about pH 4.5, and never alkalinized the stale culture solution containing organic nitrogen compounds. Organic acids (formic, acetic, propionic, butyric, benzoic, phthalic, salicylic,

gallic, oxalic, malonic, succinic, fumaric, lactic, malic, tartaric, citric and tannic acid) retarded greatly the mycelial growth of the fungi at their 1/150 mole concentration in nutrient solution. Especially, *Colletotrichum Lini* was far more sensitive than *Fusarium Lini*. The toxic action of the organic acid did not correspond always to the dissociation of the hydrogen-ions.

The temperature relations have been studied in relation to mycelial growth, thermal resistance and frost resistance. The minimum temperature for the mycelial growth of the fungi was both nearly 10°C. The optimum temperature for *Fusarium Lini* was nearly 30°C., and for *Colletotrichum Lini* it was about 25°C. The maximum temperature for *Fusarium Lini* was about 37°C., and for *Colletotrichum Lini* it was about 35°C. The resistance of these fungi to high temperature showed specific difference. *Fusarium Lini* was far more resistant than *Colletotrichum Lini*, for instance, by an exposure to a wet heat at 60°C., the former was fatally affected hardly after 3 hours, while the latter was easily killed within 10 minutes. Towards low temperature, however, both fungi were fairly strongly resistant. A series of low temperatures varying from -21°C. to -20°C. for at least 24 hours worked no fatal harm upon the vitality of the fungi.

On the pathological explanation about the characteristic wilting of flax seedling attacked by *Fusarium Lini*, Prof. BOLLEY and Dr. TISDALE have studied already in America. Their opinions, however, did not seem to be fitting to account for the case observed by us in Hokkaido. The author found a remarkable action of *Fusarium Lini* that the fungus vigorously produces gas in the decomposing process of carbohydrates. The vigour of the gas-production largely depends upon the kind of carbohydrate and nitrogen source. The gas-production being highly probable in the bodies of flax seedlings attacked by *Fusarium Lini*, the rapid wilting without showing any diseased spots may be explained as being a case of gas-emboli of xylem tubes due to the gas produced. In addition to this, it seems to be sure that *Fusarium Lini* makes the sap of the affected cells more or less alkaline considering the change of H-ion concentration of culture solution containing organic nitrogen compounds. Then the poisoning of affected cells due to the reaction change of the sap is considered also as an important pathogeny of the wilting, because the H-ion concentration of the sap of healthy, normal flax seedling is slightly acidic as from pH 5.5 to pH 5.7. As the infection of *Fusarium Lini* occurs mostly on root system of flax seedling, such morbid changes take place in the basal part of the plant, and bring about the wilting of whole plant body. On the other hand, *Colletotrichum Lini* neither producing gas nor alkalizing the culture solution, the morbid changes appeared in the case of anthracnose of flax seedlings may be explained readily as in the ordinary cases of parasitic plant diseases, by the decay of the tissues due to the direct enzymic action of the mycelium, by the seizure of part of the water and food supply by the causal fungus, and moreover, perhaps by the poisoning of the affected cells due to the increase of H-ion concentration of the sap resulting from the growth of the mycelium.

Author.

201. On a New Species of Alternaria causing a Leafspot Disease of Gomphrena globosa L. Kogo TOGASHI. (Bull. Coll. Agric. Forest. Morioka No. 9, 1926, 1-16, 4 figs.)

The results of investigation may be summarized as follows:

1. The fungus causing this disease is described under the name of *Alternaria Gomphrenae* TOGASHI.

2. According to the ELLIOTT's division of *Alternaria* and *Macrosporium*, the conidia of our fungus are longer than those of the *A. Brassicae* group and they are more slender

than those of the *A. herculeum* group.

3. The shape and size of the conidia of our fungus vary conspicuously with the environmental factors. After a rainy night the conidia measured in the following day are remarkably longer than those observed on normal days, although the difference in width is not notable.

4. At room temperature in summer the conidia germinate within three hours, and new conidia are produced after thirty-six hours, soon forming spore chains.

5. The mean value of the length of the conidia on the natural host is more than five times that in the cultural media, and the conidia formed in the latter are usually verrucose.

6. The conidia produced on the culture media can not affect the natural hosts but the conidia taken directly from the diseased leaves quite easily infected them, showing the typical leaf-spot; and when the leaves are wounded, the infection resulted more easily.

7. The germ tubes of the conidia on the natural host penetrate the epidermal walls directly and sometimes through the stomatal openings. Author.

202. Notes on Some Parasitic Fungi of Japan. Kogo TOGASHI. [Bull. Coll. Agric. Forest. Morioka No. 9, 1926, 17-29, 3 fig.]

The present article deals with 16 parasitic fungi which are either new to science or noteworthy to our mycological flora. The following two fungi are described as new species: *Physalospora japonica* TOGASHI occurring on the leaves of *Thea japonica* NOIS., *Macrophoma Commelinae* TOGASHI occurring on the leaves of *Commelina communis* L. *Puccinia Smilacis-Chinae* P. HENN. and *P. Patriniae-gibbosae* MIURA are considered as synonyms of *P. ferruginea* LEV. and *P. melanoplaca* SYD. respectively. Author.

203. On the Three Species of Fusarium which cause the Wilt-disease of Pea. Kogo TOGASHI. (Preliminary report). (Japanese). [Journ. Soc. Agric. Forest. Sapporo. 18, 19:6, 149-154.]

From the affected parts of the wilt-disease of pea the three different forms of *Fusarium* were isolated by means of single spore isolation. In this preliminary report are informed the results of studies on their morphological characters and their pathogenicity.

The conidia of the Form A have $49.80 \pm 0.35 \mu$ in the mean value of length and have 0-8 septa. The conidia of the Form C are the longest among the three forms with the mean value of $71.00 \pm 0.57 \mu$ and often recurve at both sides, having the same number of septa as in the Form A. The Form B has the shortest conidia measuring $35.67 \pm 0.65 \mu$ in mean and having 0-5 septa.

The infection power of the Form A is the strongest of the three, showing 40-75% of damages, while the Form B and Form C show 17.0% and 20.4%, respectively.

Among the strains of the Form A there is no conspicuously notable difference in pathogenicity. Author.

204. On a New Device of a Micromanipulator. (Japanese). Atsushi WATANABE. (Bot. Mag. Tôkyô 40, 1926, 115-121, with 10 figs.)

For the purpose to obtain a simple micromanipulator, the writer attached one needle-holder of micromanipulator on the tube of microscope and another one on the movable stage, in a manner that the original movement of the tube and stage are not prevented by this attachment. According to his device, we can not only use for the micromanipulator

pulation the screws of the microscope itself but also by this utilization omit the necessary screws for the micromanipulation of the apparatus to that extent. He shows the minute structures of his device graphically and discusses its strong points in details, and lastly points out from the results of its trial manufacture its practicable possibility in respect to the simplicity and exactitude.

Author.

205. Ueber die Lebendbeobachtung der Zellstrukturen, nebst dem Artefaktproblem in Pflanzenzytologie. Gihei YAMAHA. (Bot. Mag. Tôkyô, 40, 1926, 172-197.)

In den Naturwissenschaften überhaupt soll die Untersuchungsmethodik, welche natürlich die Grundlage der Ergebnisse ausmacht, ebenso sorgfältig berücksichtigt werden, wie die Untersuchung selbst. Somit gilt es auch für das Forschungsgebiet der Zytologie. Dennoch setzt man bei den modernen zytologischen bzw. karyologischen Arbeiten auf die mikroskopische Technik zu viel Vertrauen, zumal wenn man sich dabei nur auf das fixierte Objekt beschränkt, ohne aber auch das lebende mit in Betracht zu ziehen. Je näher man auf die Einzelheiten der Protoplasmastrukturen eingeht, umso schwieriger wird dieses Moment erscheinen. Um die wahren lebenden Zellstrukturen von den Artefakten genau auseinanderzuhalten, was sich jedoch nach dem Verfasser nicht so leicht durchführen lässt, hat der letztere neben den zweierlei bisher eingeschlagenen Wegen, d. h. der direkten Beobachtung der lebenden Zellen sowie der vergleichenden Untersuchung der verschiedenen fixierten Zellbilder, noch die dritte Methode angebahnt, welche darin besteht, die Zellen verschiedenen Eingriffen auszusetzen, wobei die schon im Leben vorhandenen Strukturen von den erst "nekrobiotisch" bzw. "postmortal" hinzutretenden auch morphologisch übersehbar abweichend sich verhalten können. Bei der Lebendbeobachtung muss man in erster Linie vermeiden, das Objekt selbst mit dem leisesten mechanischen Druck zu belasten und weiter dasselbe nicht lange starkem Lichte auszusetzen. Fernerhin erweist sich für die fortgesetzte Lebendbeobachtung die elektrolytfreie, isotonische und möglichst neutral reagierende Beobachtungsflüssigkeit unbedingt nötig. Es scheint sehr gefährlich zu sein, nur bei der Beobachtung der fixierten Objekte, ohne aber auf das lebende Objekt zurückzugreifen, von der Präformität bzw. Naturgetreue fixierter Bilder zu sprechen, weil alle gebräuchlichen Fixiermittel auf die lebenden Zellstrukturen in mancher Hinsicht in fast ähnlicher Weise einwirken, und es eine nicht geringe Anzahl von "unfixierbaren" Strukturelementen in lebenden Zellen gibt. Weiterhin kann ein und dasselbe Fixierungsbild bei der Fixierung nicht nur auf verschiedene Weise zur Entwicklung kommen, sondern auch völlig ungleichartigen Zellbestandteilen seinen Ursprung verdanken. Es ist beachtenswert, dass der genaue Vergleich der lebenden Strukturen mit den fixierten durch den Umstand erschwert wird, dass bei der mikroskopischen Untersuchung die Objekte in beiden Fällen für gewöhnlich bereits methodisch nicht ganz übereinstimmend behandelt werden, und zwar in Bezug auf das Beobachtungsmedium, die Objektdicke, die Lichtbrechungsverhältnisse usw. Zu diesem Zwecke empfiehlt es sich also, weiter zur Beobachtung des fixierten aber ungefärbt im Wasser oder Methylalkohol gespülten Materials zu greifen. Aus den experimentell-zytologischen Untersuchungen des Verfassers, welche andererorts ausführlich besprochen wird, ergibt sich, dass jedes Fixierungsbild streng genommen verschiedenen Stadien der Zellnekrobiosis entsprechen soll, welche wesentlich in der irreversiblen Zustandsänderung der Plasmakolloide besteht. Die letztere kann nach beiden Richtungen hin vor sich gehen, nämlich nicht nur nach der absteigenden sondern auch nach der aufsteigenden. Im ersten Fall treten manchmal Membranstrukturen verschiedener Kategorien deutlich hervor, während im letzten Fall sämtliche Strukturelemente der Zelle Homogenisierung erfahren. Es ist weiter von Interesse, dass eine Menge der Strukturmodifikationen, wie

sie bei einem Versuchsmaterial nur unter experimentell hergestellten abnormen Bedingungen erscheinen, bei einem anderen auch normalerweise wiederkehrend stattfinden. Verfasser hat bei der Betrachtung der Artefaktprobleme zweckmässig gefunden, in der Zelle zwei Kategorien der Strukturen voneinander zu unterscheiden, nämlich die kolloidalen und metakolloidalen Strukturen. Die ersteren entsprechen demjenigen feineren Bau des Protoplasmas, der sich einzig und allein auf Grund der kolloidalen Strukturen desselben erhält und demgemäss beim Zellentod, also auch bei Fixierung durch die Zustandsänderung der Plasmakolloide gründlicher Zerstörung anheimfallen. Dagegen kann die zweite Art der Strukturen, welche z. B. Zellkern, Plastiden, Chondriom, Vakuolen, Karyosomen, Chromosomen, Nukleolus usw. umfasst, scheinbar unabhängig von dem kolloidalen Zustand lebender Zellen auch postmortal bestehen. Übrigens ist es höchstwahrscheinlich, dass die netzige Struktur des Karyotins und der fädige Bau der Spindelsubstanz nicht den metakolloidalen Strukturen zuzuzählen sind. Bei der Lebendbeobachtung an den Wurzelzellen, Haarzellen und Pollenmutterzellen aus verschiedenartigen Pflanzen bestätigte Verfasser verschiedene interessante Tatsachen, so z. B. 1. Hautschicht (Plasmahaut) sowie Kernmembran sind lebend nicht immer sichtbar. 2. Mikrosomen und Vakuolen im Zytoplasma gehören zweifellos den kolloidalen, also schwer fixierbaren Strukturen an. 3. Lebende Struktur des Karyotins erscheint in den allermeisten Fällen entweder völlig homogen oder tropfig-netzig. Das sogenannte Karyotinnetz, wie es in fixiertem Zustand deutlich auftritt, stellt unbestreitbar eine Fixierungsartefakte dar. 4. Der helle Hof um den Nukleolus entspricht nicht einer lebenden Struktur, sondern bildet sich erst bei der Fixierung hauptsächlich durch die Karyotinaushöhlung, nicht aber durch die Schrumpfung des Nukleolus selbst. 5. Im Leben erscheinen Chromosomen im allgemeinen ganz optisch leer, aber niemals miteinander verklebt, solange sich die Zellen in gesundem Zustand befinden. 6. "Tassement polaire" GRÉGOIRES ebenso wie "tassement équatorial" des Verfassers ist auch in lebenden Zellen nachweisbar, wobei aber von der geringsten Verflüssigung einzelner Chromosomen miteinander keine Rede ist. 7. Der Spindelraum zeigt sich lebend ganz homogen und von jedem körnigen Elemente befreit. 8. Sogenannte Spindel- bzw. Verbindungsfäden, welche beide dem Wesen nach ganz und gar identisch sich herausgestellt haben, erscheinen mitsamt der Zellplatte Fixierungsartefakten darzustellen. 9. Achromatische Fäden treten bei der Wirkung der stark sauer reagierenden Fixagen (bei pH 1,0; bei pH 2,4 aber niemals sichtbar) sowie lipoidlösenden Substanzen und weiter bei höherer Temperatur und Hypertonie ausgeprägt hervor. 10. Die Auffassung der Spindelfäden als ein Vakuolensystem ist nach der Untersuchung und dem Dafürhalten des Verfassers trotz ihrem theoretischen Interesse nicht als ganz einwandfrei anzusehen. Autor.

206. Ueber die Zytokinese bei der Pollentetradenbildung, zugleich weitere Beiträge zur Kenntnis über die Zytokinese im Pflanzenreich. Gihei YAMAHA. (Japan. Jour. Bot. 3, 1926, 138-162, 3 Taf.)

207. Supplementa Iconum Plantarum Formosanarum II. Yoshimatsu YAMAMOTO. (40 S., mit 2 Taf. u. 24 Textfig.) (Government Research Institute: Taihoku, Formosa. 1926)

Das vorliegende Werk enthält die folgenden neuen Arten und Varietäten der *Taxaceae*, *Orchidaceae*, *Piperaceae*, *Rafflesiaceae*, *Magnoliaceae*, *Crassulaceae*, *Leguminosae*, *AQUIFOLIACEAE*, *Melastomaceae*, *Oenotheraceae* und *Acanthaceae* aus Formosa: *Myrmechis Sasakii*, *Microstylis Matsudai*, *Saccolabium kotoense*, *Peperomia kotoense*, *Mitrastemon Kanehirai*, *Michelia Kachirachirai*, *Sedum actinocarpum*, *S. arisanense*, *S. brachyrhin-*

chum, *S. nokoense*, *S. parvisepalum*, *S. sekiteiense*, *Kalanchoe Tashiroi*, *Epilobium nankotaizanense*, *Justicia procumbens* var. *riukiensis*, var. *hireuta*, var. *linearifolia*, *Justicia Hayatai*, var. *ciliata*, var. *decumbens*.
Verfasser.

208. Investigation of the Rusty-Brown Discoloration of Silk-Fibres Caused by Microorganisms. Yasutaro YENDO. [Bull. Uyeda Silk Tech. Coll., 1, 1926, 81 pp., 13 pl., 2 text-figs.]

Cocoons, raw silks, frisons and other waste silks often assume a conspicuous discoloration, if the processes of treatment or storage have not been properly carried out. The author has made experiments on this subject in the microbiological field which had hitherto not been given much attention and obtained the following results. 1) In every case, certain species of bacteria and fungi have been isolated from the discolored silk-fibres. 2) There are two kinds of bacteria, S and M, which cause the brown discoloration of silk-fibres; the former belongs to the *Bacillus subtilis* group and the latter to the *Bacillus mesentericus* group. Both are common and widely distributed everywhere but their main source is the straw in which the cocoons are spun. The bacteria from the straw first infect the cocoons and cause their discoloration through rapid reproduction in the moist, warm atmosphere. Moreover, these bacteria, producing heat resisting spores, survive the effect of high temperatures during the stiffing, drying, cooking and reeling of the cocoons and continue to thrive on raw silks, boiled cocoons left after reeling, frisons, etc. causing the brown discoloration. 3) 8 kinds of fungi, belonging to the genera *Aspergillus* and *Penicillium*, i.e., *A. glaucus*, *A. glaucus* var. *a*, *A. glaucus* var. *β*, *A. fumigatus*, *A. albus*, *P. commune* and *P. brevicaulis*, have been detected as the chief species of cocoon-fungi; they attack, moreover frisons and other waste silks causing the brown discoloration. 4) The silk-fibres, being attacked by the microorganisms, not only turn brown but become feeble on account of decomposition. 5) The reason of the brown discoloration of silk-fibres is the production of a brown pigment called melanin through the oxidation of tyrosin by tyrosinase which is derived from the decomposition of the protein substances, especially sericin of the silk, through the proteolytic action of an enzyme secreted from the microorganisms. 6) The only preventative for the discoloration of silk-fibres is to stop the development of the microorganisms.
Author.

209. Some Preliminary Studies of the Influence upon Plants of the Relative Length of Day and Night. Yoshiji YOSHII. (Rpts. Tôhoku Imp. Univ. IV. Ser., 2, 1926, 143-157, 4 pls.)

GARNER and ALLARD have observed that certain plants attain the flowering and the fruiting stages only when the length of a day falls within certain limits, and that they become more vegetative with increased length of day (*short day plants*), while other plants require a relatively long day to reach the reproductive stage and become weakly vegetative with a short day (*long day plants*). The author has studied in this respect the influence of the length of day on several plants, such as wheat, Indian millet, buckwheat, sunflower, cosmos, morning-glory, egg-plant, soybean, rice. For the lengthening of the hours of illumination Mazda electric bulbs of 300 watts were used. The results of his experiments were shortly as follows. Most of the test plants belong to the short day class, among which the morning-glory is one of the most prominent ones. In rice the behaviour is different according to the varieties: the late variety belongs clearly to the short day class, while the early one is quite indifferent towards the regulation of the light period, i. e. belongs neither to the short nor to the long day class.

210. On the Chemical Constituents of *Astragalus sinicus* L. (Japanese). Kiyohisa YOSHIMURA and Shiro FUJISE. (Bull. Kagoshima Imp. Coll. Agric. and Forest. No. 6, 1926, 25-34.)

211. On the Chemical Constituent of the Staminate Flower of *Cycas revoluta* Thunb. (Japanese). Kiyohisa YOSHIMURA and Kasuke HINO. (Bull. Kagoshima Imp. Coll. Agric. and Forest. No. 6, 1926, 59-63.)

212. On the Nitrogenous Compounds of Squash and Cucumber. (Japanese). Kiyohisa YOSHIMURA and Kôtarô NISHIDA. (Bull. Kagoshima Imp. Coll. Agric. and Forest. No. 6, 1926, 7-14.)

213. On the Chemical Constituents of Tomato. (Japanese). Kiyohisa YOSHIMURA and Kôtarô NISHIDA. (Bull. Kagoshima Imp. Coll. Agric. and Forest. No. 6, 1926, 15-23.)

214. On the Chemical Constituents of Burdock. (Japanese). Kiyohisa YOSHIMURA and Kôtarô NISHIDA. (Bull. Kagoshima Imp. Coll. Agric. and Forest. No. 6, 1926, 51-57.)

215. On the Putrefactive Products of Boiled Adzuki-Bean. (Japanese). Kiyohisa YOSHIMURA and Kôtarô NISHIDA. (Bull. Kagoshima Imp. Coll. Agric. and Forest. No. 6, 1926, 65-70.)

216. On the Chemical Study of Seed Protein of *Cycas revoluta* Thunb. (Japanese). Kiyohisa YOSHIMURA and Magosaburô TSUJIMOTO. (Bull. Kagoshima Imp. Coll. Agric. and Forest. No. 6, 1926, 83-192.)

217. Studies on the Bacterial Soft Rot Disease of *Capsicum annuum* L. (Japanese with English résumé). Hazime YOSHY. (Bull. Agric. Exp. Sta. Corea 14, 1926, 15 pp. and 3 pls.)

The soft rot disease of *Capsicum annuum* affects only the fruits, especially immature green ones. It prevails from the beginning of August, and its damage may reach 10-20% of the yield. The infection takes place mostly through the hole made by the worm *Chloridea assulta*, and is due to an organism with the group number 221.2223022. It resembles *Bacillus aroideæ*, except its indol reaction and its pathogenecity to green leaf-stalks of *Calla palustris*. Its comparison with *Bacillus aroideæ* as well as *B. carotovorus* has proven that it may be considered as a new strain of the latter species.

Abstracts Nos. 218—355

(Referring to the principal papers on Botany and allied subjects which have appeared in Japan mostly during October 1926—June 1927)

218. Experimentelle Studien über die Pilzschaden von Reissämlingen III. (Japanisch). Takuzi ABE. (Jour. Plant Protection **14**, 1927, 10 S. und 1 Taf.).

Die Schädlichkeit von *Achlya prolifer*a gegen die Reissämlingen wurde durch die Infektionsexperimente auf ihre pilzfreie Kultur in gewissen Nährlösungen sowie im Boden bestätigt. Indem sogar die Sämlingen, welche von dem Pilze nicht besonders infiziert werden, in ihrem Wachstum mehr oder minder verhindert werden, führt der Verf. diese Erscheinung auf die Ausscheidung gewisser schädlicher Substanzen seitens des Pilzes zurück. Der pH-Wert der Nährlösungen hat während der Kultur des Experimentes von 6.8 zu 8.4 verändert, und es wurde durch besondere Versuche gezeigt, dass es keineswegs den Sämlingen schädlich ist.

219. Ueber die Vererbung der Zwergheit bei den Reispflanzen. (Japanisch). Masao AKEMINE. (Mitteil. Ges. Wiss. Japan **1**, 1926, 7 S. und 1 Textfig.)

Die ursprünglich aus einer in Hokkaidô gemein kultivierten Reissippe Akage gekommenen zwergigen Sorten wurden für Versuche benutzt. Die Kreuzungen Akage (ursprüngliche Sippe) × Daikoku (Zwergsippe), Akage × Ebisu (eine andere Zwergsippe) und ihre reziproken weisen auf den monofaktoriellen Unterschied zwischen Akage und jeder von beiden Zwergsippen hin. Die F_2 -Aufspaltung der Kreuzung von zwei Zwergsippen Daikoku und Ebisu untereinander hat vier Sorten Nachkommen gegeben, nämlich Akage, Daikoku, Ebisu und eine neue besonders kleine Zwergsippe Kodaikoku, und zwar im dihybriden Verhältnisse 9:3:3:1, woraus der Verf. schliesst

Akage = **AABB**, Daikoku = **aaBB**, Ebisu = **AAbb**, Kodaikoku = **aabb**.

Die äussere und innere Morphologie sowie Physiologie der Zwergsippen wurden studiert.

220. Ueber die Sklerotienkrankheit der Reispflanzen in den Philippinen. (Japanisch). Sigeru ENDÔ. (Jour. Plant Protection **14**, 1927, 6 S.)

Dieser Aufsatz enthält ein Referat über die von Marcario A. PALO veröffentlichten Versuche über eine *Rhizoctonia*-krankheit der Reispflanzen in den Philippinen. Die Vergleichung seiner Beschreibung mit dem, was man in Japan über *Hypochnus Sasaki* kennt, hat den Verf. zur Ansicht geführt, dass beide Pilze identisch seien.

221. Florula Musashinoensis. Tôkyô 1926. 97 pp. with 10 pp. index and 2 maps.

A catalogue of plants (Angiosperms, Gymnosperms, Pteridophytes) which are found wild or cultivated within a radius of two and a half miles of the School Musasi Kôôtô Gakkô. Plants are arranged according to the system of ENGLER reversed.

222. Zur Theorie der Geschlechtsbestimmung. Valentin HAECKER. (Japan.-Deutsch. Zeitsch. Wiss. u. Techn. **4**, 1926, 275-300).

In diesem Aufsatz wird hauptsächlich die Indexhypothese der Geschlechtsbestimmung gegenüber der jetzt in der Vererbungslehre gemein angenommenen Chromosomtheorie betont. Er wird durch zahlreiche Beispiele, besonders aus dem Tierreich illustriert.

223. General Aspects of the Flora of Japan. Bunzô HAYATA. (From the Scientific Japan, published by the National Research Council of Japan on the occasion of the Pan-Pacific Congress held in Tôkyô in October-November 1926, 23 pp. and 1 map).

Besides Japan in general the floral character of each of the following regions is described: Southern Saghalien, Hokkaido and the Kurile Isl., Honshû, Shikoku, Kiushiu, Formosa, the Loochoo Isl., the Bonin Isl., the Micronesias under Japanese mandatory rule.

224. An Outline of the Experimental Study on the "Indefinite" Diseases of the Rice Plant. Takewo HEMMI. (Ann. Phytopathol. Soc. Japan **2**, 1927, 9-13, 1 fig.)

By the "indefinite disease" the writer means the injury that disturbs the germination and growth of the seedlings. He could prove experimentally that some organisms isolated from the leaf and culm of rice-plants, such as *Helminthosporium Oryzae*, *Piricularia Oryzae*, *Hypochnus Sasakii*, etc. have the power of infecting the foot and root of the rice-seedlings (s. the next No.). It may therefore be presumed that the latter have the tendency of being attacked by many fungi, if they are planted in the seed-beds favorable for the fungus growth and thereby the crop yield is more or less reduced.

225. On the Mutation of a Hyphomycetous Fungus Parasitic on the Rice Plant. Takewo HEMMI and Isamu MATSUURA. (Ann. Phytopathol. Soc. Japan **2**, 1927, 26-52, 1 pl.)

A *Brachysporium* sp. which was originally isolated from an infected rice-seedling is characterized by dark brown mycelium and conidia. On a culture started from a single spore of this species an albino sector was found, of which conidia correspond in shape and size with those of the normal strain. Repeated single-spore isolations have been made, and such cultures remain constant for the albino character, as do the cultures made by isolating bits of mycelium. The temperature relation, as well as the degree of virulence do not differ in the normal and mutant strains.

226. Experimentelle Studien über die Pilzschaden von Reissämlingen II. (Japanisch). Takewo HEMMI und Kuniomi YOKOGI. (Jour. Plant Prot. **13**, 1926, 9 S. mit 1 Taf.)

Die Schädlichkeit von *Piricularia Oryzae* BR. et CAV., *Helminthosporium Oryzae* BRED. et HAAN und *Hypochnus Sasakii* SHIRAI gegen die Reissämlingen ist wohl bekannt, doch ob sie (ausgenommen *Helminthosporium*) direkt die Wurzeln oder die basalen Teile des Halmes infizieren können, bleibt noch unentschieden. Mittelst

einer Reihe von Infektionsversuchen konnten die Verfn. die letztere Tatsache sicherstellen, wenn auch ob ebenso in der Natur die direkte Infektion der Wurzeln erfolgen kann, noch unbekannt ist. Die Infektionskraft ist bei *Helminthosporium* am grössten, weit schwächer bei *Piricularia*, und etwas schwächer bei *Hypochnus* als bei der letzteren.

227. Microbiological Changes in the Soil of Perpetual Pea Field and the Possible Causes of "Iyati" (Sick Soil) of the Field. (Japanese with an English résumé). Iwao HINO and Kakugorô NAKATA. (Jour. Sc. Agric. Soc. No. 287, 1927, 430-436+1).

It is the well-known fact that in the case of many plants their continued cultivation in one and the same field leads to their poor growth and even to the whole cessation of growth, the phenomenon known by the name sick soil ("Iyati" in Japanese). This is especially the case in peas. The results of the authors' experiments during 1923-26 concerning the perpetual cultivation of pea in the same field are as follows.

The culture experiments have proven that the crop yield is directly proportional to the bacterial contents in the soil: the higher the latter the larger the crop yield. Now it was further ascertained that the number of soil bacteria is negatively correlated with that of soil protozoa, especially the ciliates, and this is due to the fact that the latter are extremely voracious and diminish the number of soil bacteria considerably. The cause of sick soil by continued pea cultivation in the same field is chiefly due to the diminished bacterial activity caused by the protozoa, especially the ciliates. Amoebae in soil are not so effective in the latter process. Further, the abundant presence of soil fungi makes the soil sick and inhibits the germination of seeds, but this is only temporary. Perpetual pea cultivation acidifies the soil reaction, but it has no effect on the bacterial contents of the soil and consequently on the crop yield.

228. Studien über die Fäulniskrankheit von *Amorphophallus Rivieri*. (Japanisch). Eikiti HIRATA. (Mitt. aus d. landw. Versuchssta. zu Tôkyô No. 48, 1927, 45 S. und 6 Taf.)

Die in verschiedenen Gegenden Japans sehr verbreitete Fäulniskrankheit von *Amorphophallus Rivieri* verursacht die Schädigung an verschiedenen Teilen der betreffenden Pflanze, und zwar besonders vom Frühsommer bis zum September. Die Krankheit ist auf die Wirkung eines *Bacillus* zurückzuführen, welcher zu einer Linie von *Bacillus carotovorus* JONES gehört. Die Kulturexperimente auf verschiedenen Nährböden wurden ausgeführt. Die chemische Reaktionen und die Temperaturverhältnisse des Organismus wurden untersucht. Eine auf solche Versuche gegründete ausführliche Diagnose wird angegeben. Der Organismus kann auch auf *Arisaema*, *Allium*, *Raphanus*, *Brassica*, *Daucus*, Kartoffel parasitieren.

Verschiedene Bekämpfungsmethoden sind vorgeschlagen.

229. On the Sex Determination in Hemp, *Cannabis sativa*, L. (Japanese with an English résumé). Kenzi HIRATA. (Jour. Soc. Agric. & Forestr., Sapporo 19, 1927, 39-54).

Intersexual individuals are often met with in hemp, both under normal and abnormal conditions. All offspring derived from the selfing and mutual crossing of female intersexes as well as the hybridization of the female with the pollen of female intersexes were found to be pure females or female intersexes. The offspring derived from various crossings with the male intersexes have shown various sex-forms. In view of such observations the author concludes that sex determination in hemp should rest on the genetic basis, and that the inheritance is of XY-type, as already shown by MCPHEE. The author thinks however that the mere presence of either one or two X-chromosomes does not suffice for the definite sex determination. According to him both male and female factors are contained in the X- and Y-chromosome respectively: in the X-chromosome the valency of the female factor (or factors) is higher than that of the male, while, on the contrary, in the Y-chromosome that of the male factor (or factors) is higher than the female, so that the X- and the Y-chromosome has a net female and male tendency respectively, and the production of either sex is due to the combined action of these two sets. Individuals differ naturally in their respective valency of the male or female factor, and those produced as the results of such combination are very various in their male or female tendency. In the normal sex-type the difference or the balance of the male valency over the female one (or the reverse) is large and much surpasses the critical point. The smaller this difference, i.e. the nearer the critical point, the easier the induction of the intersexuality by the environmental action.

230. Studies on the Flax-rust. I. (Japanese). Naohide HIRATSUKA. (Jour. Soc. Agric. & Forestr. **18**, 1926, 91-112).

231. Studies on the Flax-rust. II. (Japanese). Naohide HIRATSUKA. (Jour. Soc. Agric. & Forestr. **19**, 1927, 76-92).

232. Notes on Melampsorium Parasitic on the Japanese Species of *Alnus*. (Preliminary report). (Japanese). Naohide HIRATSUKA. (Jour. Soc. Agric. & Forestr. **18**, 1926, 78-90). See No. 239.

233. On the Abnormal Teleutospore-form of *Melampsora*. (Japanese). Naohide HIRATSUKA. (Jour. Soc. Agric. & Forestr. **18**, 1926, 70-74).

234. On Relationship of *Pucciniastrum* and *Uredinopsis*. (Japanese). Naohide HIRATSUKA. (Jour. Soc. Agric. & Forestr. **18**, 1926, 75-86).

235. Japanese Species of *Melampsora* Parasitic on *Larix*. (Japanese). Naohide HIRATSUKA. (Jour. Soc. Agric. & Forestr. **19**, 1927, 180-195).

236. Japanese Species of the *Pucciniastreae* Parasitic on the Japanese *Ericaceae*. (Japanese). Naohide HIRATSUKA. (Jour. Soc. Agric. & Forestr. **19**, 1927, 52-73). See No. 239.

237. Some Germination Experiments with the Teleutospores of Several Species of the Melampsoraceae. (Japanese). Naohide HIRATSUKA. (Jour. Soc. Agric. & Forestr. **19**, 1927, 79-87).

238. Thekopsora Parasitic on the Japanese Species of Prunus. (Japanese). Naohide HIRATSUKA. (Jour. Soc. Agric. & Forestr. **19**, 1927, 83-94). See No. 239.

239. Studies on the Melampsoraceae of Japan. I-V. Naohide HIRATSUKA.

- I. *Melampsoridium* parasitic on the Japanese species of *Alnus*.
- II. *Thekopsora* parasitic on the Japanese species of *Prunus*.
- III. *Thekopsora* on the Japanese species of *Ericaceae*.
- IV. Notes on some species of *Pucciniastrum* in Japan.
- V. Notes on some species of *Chrysomyxa* in Japan.

(Jour. Facul. Agric. Hokkaidō Imp. Univ. Sapporo, **21**, 1927, 1-41).

In the present paper, the author described 22 species of the Japanese Melampsoraceae, among which 8 species are new to science and 8 species new to the mycological flora of our country.

Species new to science:

- Melampsoridium Alni-pendulae* HIRATSUKA
- M. Hiratsukanum* ITÔ
- M. Alni-firmae* HIRATSUKA
- Thekopsora Pseudo-cerasi* HIRATSUKA
- Th. Hakkōdensis* ITÔ et HIRATSUKA
- Th. Menziesiae* HIRATSUKA
- Th. Tripetaleiae* HIRATSUKA
- Pucciniastrum Hydrangeae-petiolariidis* HIRATSUKA.

Species new to Japan:

- Thekopsora myrtilлина* KARST.
- Th. sparsa* (Wint.) P. MAGN.
- Pucciniastrum Circaeae* (THÜM.) SPEG.
- P. Goodyerae* ARTH.
- P. Fyrolae* (KARST.) SCHRÖT.
- Chrysomyxa Cassandrae* TRANZSCH.
- Ch. Empetri* SCHRÖT.
- Ch. ledicola* LAGERH.

Author.

240. A List of Uredinales Collected in the Vicinity of Lake Akan, Hokkaidō. Naohide HIRATSUKA. (Transact. Sapporo Nat. Hist. Soc. **9**, 1927, 225-238, with a Japanese résumé).

Uredinales collected by the author in the vicinity of Lake Akan, Hokkaidō are enumerated. They contain: *Miyagia* 1 sp., *Phragmidium* 7 sps., *Pucciniastrum* 45 sps., *Triphragmium* 1 sp., *Uromyces* 13 sps., *Xenodochus* 1 sp., *Calypsotheca* 1 sp., *Chrysomyxa* 3 sps., *Melampsora* 5 sps., *Melampsoridium* 3 sps., *Pucciniastrum* 5

sps., *Thekopsora* 5 spp., *Uredinopsis* 2 spp., *Coleosporium* 5 spp. and *Uredo* 1 sp. Among them, the two species, *Puccinia uralensis* TRANZSCH. and *Thekopsora guttata* (SCHRÖT.) SYD. are new to the mycological flora of Japan.

241. On two Species of Coleosporium Parasitic on the Japanese Compositae. Naohide HIRATSUKA. (Transact. Sapporo Nat. Hist. Soc. **9**, 1927, 217-224, with a Japanese résumé).

The author demonstrated the genetic connection of the two Japanese species of *Coleosporium*, *Coleosporium Eupatorii* ARTH. and *C. Saussureae* THÜM. The aecidial stage of these two species occurs on the leaves of *Pinus koraiensis* and *P. pumila* respectively. He found also the uredo- and teleutostage of the former species on *Eupatorium japonicum* and *E. Sachalinense* and that of the latter species on the five different species of *Saussurea*, viz. *Saussurea japonica*, *S. Maximowiczii*, *S. Riederi*, *S. Tanakae* and *S. Ussuriensis* in Northern Japan. Author.

242. List of the parasitic Fungi Collected in Horomui Moor-land, Hokkaidô. (Japanese). Naohide HIRATSUKA and Yasu HOMMA. (Jour. Soc. Agric. & Forestr. **19**, 1927, 74-78).

In the present paper, the parasitic fungi collected in Horomui moor-land, Hokkaidô are enumerated. They contain: Synchytriaceae 2 spp., Cladochytriaceae 1 sp., Erysiphaceae 8 spp., Phacidiaceae 1 sp., Hypocreaceae 1 sp., Ustilaginaceae 3 spp., Pucciniaceae 2 spp., Melampsoraceae 3 spp., Coleosporiaceae 1 sp. and Sphaerioidaceae 1 sp. Authors.

243. Revisio Graminum Japoniae XII. Masaji HONDA, (Bot. Mag. Tôkyô 41, 1927, 6-15). This article contains the following items:—

1. The descriptions of 3 new species of *Ischaemum*. (*I. hokianum*, HONDA, *I. papillosum*, HONDA and *I. villosissimum*, HONDA).
2. The new name *Rottboellia japonica* HONDA is to be combined from *Rottboellia compressa* var. *japonica*, HACKEL.
3. The name *Leptochloa filiformis*, BEAUVOIS is more correct than *Leptochloa filiformis*, ROEMER et SCHULTES.
4. *Leptochloa fusca*, KUNTH is better than *Diplachne fusca*, BEAUVOIS to adopt.
5. A new combination *Tripogon longe-aristatus*, HONDA and a new variety *T. longe-aristatus* var. *japonicus*, HONDA are reported.
6. A new species *Triodia formosana*, HONDA is described here. The present genus is new to the flora of Formosa, and moreover it is to be considered as a new section *Bromodia*, HONDA.
7. The description of one new species *Calamagrostis exaristata*, HONDA.
8. *Molinia japonica* var. *rupestris*, KOIDZUMI is to be changed to its combination, such as *Moliniopsis japonica* var. *rupestris*, HONDA.
9. *Arundo Donax* var. *coleotricha*, HACKEL is to be raised its rank such as *Arundo coleotricha*, HONDA, and by the way one new variety of it, *Arundo coleotricha* var. *barbigera*, HONDA, is reported. Author.

244. Revisio Graminum Japoniae XIII. Masaji HONDA. (Bot. Mag. Tôkyô 41, 1927, 485, 377-389). The following 9 items are contained in this paper.

1. The descriptions of 8 new species and 1 new variety:—
Oplismenus psilostachys, HONDA
Anthoxanthum viridescens, HONDA
Aristida formosana, HONDA
Agrostis nipponensis, HONDA
Agropyron Mayebaranum, HONDA
Agropyron japonicum, HONDA var. *Hackelianum*, HONDA
Agropyron formosanum, HONDA
Eragrostis Niwahokori, HONDA.
2. MIQUEL's *Ischaemum antheophroides* is to be divided into 2 varieties, α *typicum* and β *eriostachyum*, HONDA.
3. *Hierochloe pluriflora*, KOIDZUMI is to be considered as *Hierochloe pauciflora*, R. BROWN, and *Trisetum leve*, TAKEDA is to be changed as *Deschampsia Takedana*, HONDA.
4. The comparison of *Agropyron semicostatum*, NEES. and *Agropyron ciliare*, FRANCHET, and one new combination *A. ciliare* var. *pilosum*, HONDA.
5. *Eragrostis pilosa*, BEAUVOIS is different from the above cited *E. Niwahokori*, HONDA.
6. The establishment of a new section *Armillariella*, HONDA of the genus *Eragrostis*, *E. ferruginea*, *E. minor* and *E. pusillus* belong to this new section.
7. The proposition of a new section *Agonomelica* of the genus *Melica*. This new section contains one species *M. Onoei*.
8. DOMIN's *Koeleria tokiensis* is but a variety of *Koeleria gracilis*, PERSOON, so it is changed to *K. gracilis* var. *tokiensis*, HONDA.
9. *Tripogon longe-aristatus*, HONDA reported in the preceding paper is to be corrected as *Tripogon longearistata*, NAKAI, reported 13 years ago.

245. Ueber die Zeit und Ordnung des Blütenöffnens bei *Setaria italica*. (Japanisch). Tetu HOSINO und Tatzu TUTUMI. (Notes from the Agric. Exp.-Station Korea 6, 1926, 443-454 mit Fig.)

Die folgenden genauen Beobachtungen über das Blütenöffnen von *Setaria italica* wurden in Suwon (Korea) gemacht, und zwar an verschiedenen Sippen. Der Oeffnungsvorgang dauert ungefähr einer Woche nach der Ährensprössung. Er geschieht zweimal pro 24 Stunden: erstens von 1 Uhr-3 Uhr $\frac{1}{2}$ Vorm. und zweitens von 7 Uhr $\frac{1}{2}$ -10 Uhr $\frac{1}{2}$ Nachm. Der Oeffnungsdauer beträgt im Mittel 2-2 $\frac{1}{2}$ Stunden, selten 1 oder 4. Bei diesem Vorgange öffnet sich jede Blüte zuerst schnell, dann sinkt allmählich in der Geschwindigkeit, bleibt während ungefähr 20-30 Min. ganz ruhig, um dann langsam sich zu schliessen. Das weiteste Winkel des Blütenöffnens beträgt 30°.

246. On Some Chaetoceras of Japan I. Jiro IKARI. (Bot. Mag. Tôkyô **40**, 1926, 517-534, 15 figs.)

A number of new and imperfectly known species of *Chaetoceras* collected by the author in the vicinity of his Seto Marine Biological Laboratory are described and partly illustrated. The following are the new species: *C. pseudodichaeta*, *C. pseudoaurivillei*, and *C. setoensis*.

247. On Bacteriastrum of Japan. Jiro IKARI. (Bot. Mag. Tôkyô **41**, 1927, 421-432 with a Japanese résumé.)

A number of *Bacteriastrum* species collected from various localities of Japan are described and partly illustrated. Among others there are *B. hyalinum* LANDER var. *princeps* (CASTRACANE) IKARI comb. nov. and *B. elongatum* CLEVE var. *diversum* IKARI var. nov.

248. Genetic Studies on Morning Glories XVIII-XIX. (Japanese with an English résumé.) Yoshitaka IMAI. (Bot. Mag. Tôkyô **40**, 1926, 655-657; **41**, 1927, 389-398).

A genetic analysis showed the fact that the representation of fasciation in the Japanese Morning Glory, at least in my specimens, is determined by three recessive factors, f^1 , f^2 and f^3 . There occur about 20%—25% of crossing over between f^1 and f^2 , and these two factors link closely with p , pear leaf factor. The frequency of crossing over between f^1 and p is ca. 2.5%. The strong accompaniment of the fasciated stem and pear leaf is due to the linkage. In the hybrid progeny, there appeared some false normals. Under these conditions the segregating mode of fasciation in the hybrid progeny was very complicated. The factor f^3 links with v , variegation factor, according to a moderate intensity.

A partial inhibitor affecting the manifestation of white margin on the corolla of the Japanese Morning Glory was detected in some segregating pedigrees. The factor produces an incomplete white margin, but not completely or greatly suppresses its production as the factors F^h and F^f . The factor F^p , the inhibitor in question, links with D_i , a factor diluting the flower color, in about 3 per cent of crossing over. There is a pair of the white-margin factors, presumably designated as F and f , linking with the willow allelomorphs very strongly. The factor f cannot produce a white margin in the non-willow leaves, while it often manifests the pattern in the willows, though the quantity of the white margin is very small. Author.

249. On the Variability of *Amaranthus paniculatus*. (Japanese with an English résumé.) Yoshitaka IMAI and Bensô KANNA. (Bot. Mag. Tôkôy **40**, 1926, 536-545).

The white-eared form of *Amarantus paniculatus* gives mosaic-eared and red-eared plants in the average proportion of 8.60% and 6.75%, respectively, in its offspring. Nearly the same result is obtainable in the progeny of red ears of mosaic plants. So the vegetative variation is not accompanied by any factorial change. From this fact we may compare our *Amarantus* with the cases of the striped flowers of *Mirabilis* and *Celosia*. Actually, however, the red plants of our *Amarantus* also give nearly the same result, so the case is quite particular.

The mixing proportion of red and mosaic plants in each pedigree varies so much that we cannot attribute the variability to a mere deviation. Our "potency" hypothesis may explain the unusual results. Authors.

250. Uredinales collected in the Hakkôda Mountain Range, Prov. Mutsu, Honshû. (Japanese with English résumé). Seiya ITÔ and Naohide HIRATSUKA. (Transact. Sapporo Nat. Hist. Soc. **9**, 1927, 259-273).

This paper was intended to report the rust fungi collected by ourselves in the Hakkôda mountain range on September 26 and 27, 1926. The total number of species we have collected is fifty, in which *Uromyces* is represented by 4 sps., *Pileolaria* 2 sps., *Puccinia* 19 sps., *Phragmidium* 1 sp., *Triphragmidium* 1 sp., *Uropyxis* 1 ps., *Melampsora* 3 sps., *Melampsoridium* 2 sps., *Pucciniastrum* 2 sps., *Thekopsora* 5 sps., *Uredinopsis* 1 sp., *Cronartium* 1 sp., *Coleosporium* 7 sps. and *Aecidium* 1 ps.

Among these species, one species, *Thekopsora hakkôdensis* ITÔ et HIRATSUKA is new to science, one species, *Puccinia Fergussoni* BERK. et BR. is new to Japan, 5 species, *Uromyces Moehringiae* ITÔ et HIRATSUKA, *Thekopsora Menziesiae* HIRATSUKA, *Th. myrtillina* KARST., *Th. vacciniarum* KARST. and *Coleosporium Eupatorii* ARTH. are new to Honshû, and forty-five species are common to Hokkaidô and Honshû.

Authors.

251. Production of the Ascigerous Stage in Culture of Helminthosporium Oryzae. (With a Japanese résumé) Seiya ITÔ and Kazue KURIBAYASHI. (Ann. Phytopathol. Soc. Jâpan **2**, No. 4, 1927, 1-8, 3 pls.).

For the study of rusty rice (rice seeds with a brownish discolored or spotted surface) rice seeds were collected from various parts of Hokkaidô. *Helminthosporium Oryzae* was often isolated from such seeds. The authors were able to get the mature perithecia in the culture of conidia and hyphae isolated from the grains, pericarps and seeds, especially from the last. For the culture the rice-culm decoction agar is most suitable and the optimum temperature is 25°C. The authors propose a new name *Ophiobolus Miyabeanus* for this fungus; the description of ascigerous stage is as follows: Perithecia black, thin pseudoparenchymatous, globose or depressed globose, with ostiolar beak, 560-950×368-777 μ . Asci numerous, cylindrical or long fusiform, 142-235×21-36 μ , with 1-8, mostly 4 or 6 ascospores. Ascospores filiform or long cylindrical, coiled in a close helix, 6-15, mostly 9-12, septate, hyaline or light olive green, 250-468×6-9 μ .

252. Physiological Anatomy of the Root-Nodule of Wistaria sinensis Tadao JIMBO. (Proc. Imp. Acad. **3**, 1927, 164-166).

The root-nodules of *Wistaria sinensis* consist of one-four round portions arranged in a chain, each of which represents an annual growth. The greater part of the nodule is occupied by the bacterial tissue. Between the latter and the deeper part of the meristem we see the transitionary part consisting of embryonal cells infected by filamentous zooglea (infection threads). Soon after the infection there occurs the hypertrophy of the cell and its nucleus as well as the enrichment of the cytoplasm, and then the bacteria which become free on account of the dissolution of the slimy

mass of the thread come into the cytoplasm and fill it up completely. At the end of the growing period the bacterial cells degenerate. In the resting period the meristem cells do not multiply, and cells invaded by the thread display no more change, the bacteria being retained within the threads.

253. The Comparison of Chromosomes among Different Species in *Triticum*. Fuyuwo KAGAWA. (Proc. Imp. Acad. **3**, 1927, 304-306).

The number and length of chromosomes as well as the constrictions of each of them were studied in the root-tips of *Triticum monococcum*, *dicoccum*, *polonicum* and *vulgare*. In *T. monococcum* there are 14 chromosomes. In *T. polonicum* and *dicoccum*, both of which are tetraploid, there are 28 chromosomes, while *T. vulgare* which is hexaploid contains 42 chromosomes. Each chromosome is distinguished by one or two constrictions, and the place of constriction is characteristic of each particular one. When one considers the chromosomes of each of the two tetraploid species just mentioned, basing on the number and condition of their constriction it was observed that the maximum number of homologous chromosomes is 2 (3 in a few doubtful cases), so that 28 chromosomes of each tetraploid species do not present the 4-fold multiplication of any ground set of chromosomes, corresponding to tetraploidy. Nor in the hexaploid species was the 6-fold multiplication of any ground set of chromosomes observed, corresponding to hexaploidy. In view of the facts above mentioned the author's conclusion is as follows: the four *Triticum* species mentioned do not present the polyploidy in the sense that this condition is due to the multiplication of one ground set of chromosomes; it seems probable that the chief causes which led to the polyploidy in *Triticum* species are the crosses between certain ancestral forms having different chromosome contents with each other and the special chromosome behavior which followed such crosses.

254. On the Natural Crossing of *Solanum Melongena* Continued. (Japanese). Yôiti KAKIZAKI. (Japan. Jour. Genetics **4**, 1926, 39-42).

In 1923 a certain number of the strains of *Solanum Melongena* with black and white fruits were planted alternately at a distance of somewhat less than 1 metre from each other. The natural crossing between the two strains has taken place, and its ratio was found to be 2.96%.

Furthermore, the two strains were planted at the distance of 3, 10, 30 and 50 metres respectively. The ratio of crossing was found to be for example 0.46% for 3 metres distance, 0.30% for 30 and 0 for 50.

255. On the Inheritance of Balsam. (Japanese with an English résumé). Bensô KANNA. (Bot. Mag. Tôkyô **40**, 1926, 599-619, 5 figs.)

The writer detected nine pairs of allelomorphs in balsam. Three of them constitute a linkage group. Striped flowers were also one of his subject which were hoped to be solved. They produce habitually monochromatic flowers as mutants. The flowers in ground color are also thrown by the striped strains. The monochromatic bud-variation of flower color on the striped plants occurs frequently, but is not inherited.

Author.

256. Ueber die Vorbehandlung einiger pflanzlicher Objekte bei der Fixierung der Pollenmutterzellen. Hitoshi KIHARA. (Bot. Mag. Tōkyō **41**, 1927, 124-128, 3 Textfig.)

Nach den Beobachtungen des Verf. über die Kernteilung der Pollenmutterzellen bei verschiedenen Pflanzen, besonders *Rumex*-Arten, sieht man nicht selten, dass die metaphasischen Chromosomen zueinander so verkleben (eigentlich enge Annäherung), dass ihre Zählung kaum möglich ist, wenn auch in der Anaphase sie einzeln liegen und leicht gezählt werden können. In den während gewissen Stunden abgekühlten Materialien (z. B. bei *Rumex patientia* 6-stündige Abkühlung in fließendem Wasser von 12.5°C) konnte er z. B. in verschiedenen Fällen die metaphasischen Chromosomen im nicht verklebten Zustand beobachten und sie leicht zählen.

257. Contributiones ad Salicologiam Japonicam II. Arika KIMURA. (Bot. Mag. Tōkyō **40**, 1926, 633-643.)

Eine Anzahl von japanischen Weidenarten und -varietäten sind eingehend beschrieben, von denen die folgenden neu sind: *Salix Hiraoana*, *S. H.* var. *brachystachys*, *S. mictostemon*, *S. Nakaii*, *S. serisaefolia*, *S. thaymasta*, *S. vulpina* var. *psilostachys*.

258. Über die Ernährung der Pilze mit den Kobaltamminkomplexsalzen. Kōno KINOSHITA. (Acta Phytochimica, **3** (1927), 31-50, 4 Fig. und 2 Tafeln.)

Verf. beschäftigt sich mit der Frage: Wie verhalten sich die N-haltigen Gruppen, die durch Nebervalenzen an Zentralmetallatom gebunden sind, bei der Assimilation durch einige Schimmelpilze? Die Versuchspilze, *Aspergillus niger*, *A. oryzae* und *Penicillium glaucum*, können zwar verschiedene Komplexsalze, z. B. Luteo-, Purpureo-, Croceo-, Flavo-, Roseo-, Xanthosalz, als N-Quelle verwerten. Der Stickstoff in metallkomplexen Verbindungen scheint aber im allgemeinen ziemlich schwer assimilierbar zu sein, sodass die Pilze damit nur langsam aufkommen. Die Metallkomplekkationen werden dabei als solche von den Pilzzellen aufgenommen, worauf der ungemein hohe Kobaltgehalt der aufgewachsenen Myzelien hindeutet. In der Kultur von *Aspergillus oryzae* entsteht Kojisäure, eine Oxy-γ-Pyronverbindung, in einer beträchtlichen Menge, was im Zusammenhang mit der erschwerten Stickstoffernährung durch Komplexsalze steht. Der relative Mangel an üblicher Stickstoffquelle ruft auch denselben Effekt hervor. Auch *Asp. niger* erzeugt bei der Darbietung der Kobaltamine grössere Mengen Säuren. Die beim relativen N-Mangel gebildeten Säuren sind dabei nicht einheitlich; es wurden nachgewiesen Citronen-, Wein-, Oxal-, Aepfel- und Bernsteinsäure. Verf.

259. Vermehren sich die Plastiden auch in der Meristemzelle von Hydrilla verticillata nur durch Teilung oder nicht? Kogane KIYOHARA. (Bot. Mag. Tōkyō **41**, 1927, 211-218, 1 Taf. und 1 Textfig.)

Nach den mit CARNOYSchem oder Sublimat-Alkohol-Gemisch naturgetreu fixierten Meristemzellen in den Blattanlagen sowie dem Vegetationskegel von *Hydrilla verticillata* sind die Plastiden rundlich. Während der Karyokinese behalten sie ihre

rundliche Gestalt. In der Metaphase beginnen sie sich zu zwei Gruppen zu verteilen und in der Anaphase sammeln sie an beiden Polregionen an. Dann erst werden sie hantelförmig, und nach der Vollendung der Karyokinese erfolgt ihre intensive Vermehrung durch Teilung.

Die Neubildung der Plastiden aus Chondriosomen wurde niemals beobachtet. Wenn man für die Fixierung statt des oben genannten Gemisches das REGAUDSche oder CHAMPYSche gebraucht, welche für die Fixierung der Chondriosomen vielfach benutzt wird, werden die rundlichen Plastiden stark verunstaltet: sie zeigen dann eine fadenförmige oder eine langgestreckte, an beiden Enden verdickte Gestalt, welche an derselben der typischen Chondriosomen (MEVES) bzw. der sog. Übergangsformen der letzteren zu den Plastiden (GUILLIERMOND usw.) erinnert.

260. Ueber den Einfluss der Aussenbedingungen auf das Blütenöffnen der Reispflanzen III. Einfluss der Temperatur. (Japanisch). Yakiti KOBAYASI. (Jour. Sc. Agric. Soc. No. 290, 1927, 20-29).

In der Natur erfolgt immer das Blütenöffnen der Reispflanze, wenn die Temperatur bei 8 Uhr Morgen 27° — 28° C beträgt. Die Optimum-Temperatur dafür beträgt $30^{\circ} \pm 2^{\circ}$ C. Nach den Verf.s Studien über die im Thermostat gehaltenen Rispen ist die Optimum-Temperatur für das Blütenöffnen ganz gleich wie in der Natur. Die Bestäubung findet reichlich unter hoher Temperatur statt. Unter niederer Temperatur wird das Blütenöffnen verspätet und ihre Zeitdauer verlängert. Unter 25° und über 35° werden das Aufspringen der Antheren und dementsprechend die Bestäubung mehr oder minder verhindert. Der Oeffnungswinkelgrad der Spelzen ist von der Temperatur ganz gleichgültig.

261. Über die Ergebnisse der Pedigreezucht der semisterilen Reispflanzen. Mantarō KONDO. (Ber. Ōhara Inst. landw. Forsch. 3, 1927, 275-289 m. 1 Tabelle; Proc. Imp. Acad. 3, 1927, 97-101).

Im Jahre 1917 kamen in einer Familie der Reissippe Sinriki ausser den normalen Fertilpflanzen ungefähr 26% Semisterilpflanzen vor. Es ist klar, dass die Elite dieser Familie im früheren Jahre eine spontan entstandene Heterozygote **Ff** sein muss, wenn man mit **FF** die fertilen und mit **ff** die semisterilen Pflanzen zeigt.

Die Kultur der folgenden Generationen haben die Resultate ergeben, dass die semisterilen Nachkommen nicht immer konstant sind, wie aus ihrer rezessiven Charakter erwartet werden muss, sondern sich sehr oft zu den Fertil- und Semisterilpflanzen aufspalten, ja sogar kommt es zeitweise vor, dass alle ausnahmslos zu den Fertilpflanzen sich verwandeln. Auch bei den Nachkommen der Fertilpflanzen erwarten wir theoretisch das Verhältnis 1:2 (1 **FF**: 2 **Ff**) der homo- und heterozygotischen Pflanzen, doch sehr oft ist es aus dem erwarteten verschieden, und zwar zum Gunsten von **Ff**, sodass eine Anzahl von Homozygoten **FF** zu den Heterozygoten **Ff** sich verwandelt haben müssen.

Die Erklärung der oben erwähnten Phänomene sucht der Verf. in der Unbeständigkeit der beiden Faktoren **F** und **f**, wobei die Verwandlung von **F** zu **f** und die umgekehrte leicht stattfinden können.

262. Untersuchungen über die weissgestreifte Reispflanze (Shimaine). Mantarô KONDÔ, Motoharu TAKETA und Sumita FUJIMOTO. (Ber. Ôhara Inst. landw. Forsch. **3**, 1927, 291-317, 12 Tafeln).

Eine in Deutsch geschriebene Abhandlung eines schon in Japanisch erschienenen Aufsatzes. (S. Japan. Jour. Bot. **3**, 1926, (9), Nr. 32).

263. Entwicklungsmechanische Betrachtungen über die Differenzierung der Geschlechtsorgane bei den Blütenpflanzen. Kwan KORIBA. (Bot. Mag., Tôkyô, **41**, 1927. p. 110-117).

Der Verfasser ist der Meinung, dass die Geschlechtsverhältnisse der Blüten, zumal bei den heterogamischen, nicht ausschliesslich von den geschlechtsbestimmenden Faktoren, sondern auch von den entwicklungsmechanischen Verhältnissen am Blütenboden beeinflusst werden, besonders wenn die Blumenblätter auf dem Blütenboden oder die Blütenknospen auf der Infloreszenz in gedrängtem Zustand sich befinden. Er nimmt hierbei die Zertationsentwicklung der Organanlage an, die bei denjenigen Pflanzen öfters vorkommt, deren Blütenboden je nach den Wachstumsverhältnissen leicht in bezug auf seine Grösse variiert, wodurch die Anzahl der Organe beschränkt wird.

Er bemerkt ferner, dass die physikalische Konsistenz zweierlei geschlechtlichen Substanzen einen gewissen Gegensatz aufweist, und der morphotische Unterschied dieser zweierlei Geschlechtsorgane teils auch dadurch erklärbar ist. Verf.

264. Ueber die Erregbarkeit der Blattgelenke der welkenden *Mimosa pudica*. Riichiro KÔKETSU. (Bot. Mag. Tôkyô. **41**, 1927, 78-99).

Die Veränderung der Erregbarkeit der welkenden *Mimosa pudica* gegen die Reizung mittelst des Induktionsstroms wurde studiert, indem die Bestimmung der Erregbarkeit an den primären und tertiären Gelenken des Blattes ausgeführt wurde. Um die Beziehung zwischen der Veränderung der Erregbarkeit der Blattgelenke und derselben des Wassergehaltes klar zu machen, wurde auch der Wassergehalt des Blattes oder des Blattgelenkes bestimmt.

Es wurde dabei konstatiert, dass die Erregbarkeit des Gelenkes durch das Welken des Blattes nicht vermindert, sondern manchmal vielmehr gesteigert war, während seine Reagierbarkeit immer mehr vermindert wurde. Diese hohe Erregbarkeit des Gelenkes dauerte immer bis zum kritischen Welkungspunkte, wo das Gelenke jetzt nicht mehr reagierbar geworden war. Andererseits wurde der Wassergehalt des Blattes während des Welkens fortschrittlich vermindert, aber die Verminderung des Wassergehaltes im Gelenke verlief viel langsamer als in dem anderen Blattteile. Daher war die Erhaltung der hohen Erregbarkeit des Gelenkes eines gewelkten Blattes wenigstens teilweise durch den hohen Widerstand des Gelenkes gegen die Wasserentziehung bedingt.

Die einmal in dem kritischen Zustand des Welkens verfallenen Blätter konnten aber durch erneute Wasseraufnahme ihre Erreg- und Reagierbarkeit wieder erhalten. Es liess sich das so ausdrücken, dass die gewelkten Blätter in dem kritischen Punkte zwar nicht die Erregbarkeit selbst, sondern nur die Reagierbarkeit wegen Wassermangels verloren. Die Erregbarkeit solch eines wieder erhaltenen Blattes war merk-

würdigerweise meistens fast normal. Das Gelenk eines einmal kritisch gewelkten Blattes pflegte aber meistens früher oder später starr zu werden und endlich abzufallen, ein Beweis, dass das betreffende Gelenk schon teilweise pathologisch durch das Eintreten der Degeneration geworden war.

Der Verfasser schloss also, dass die Erregbarkeit des Gelenkes von *Mimosa pudica* normal, fast normal oder höher als normal bis in die Nähe des Punktes erhalten bleibt, in dem die Degeneration des Gewebes oder des Plasmas beginnt. Mit anderen Worten konstatierten diese Versuchsergebnisse wenigstens, dass die Blätter dieser Pflanze, selbst wenn ihre wichtigen physiologischen Funktionen wie Assimilation, Transpiration usw. wegen Wassermangels stark gehemmt sind, doch noch die Erregbarkeit in ihren Gelenken in hohen Grade erhalten haben können. Verf.

265. Die Gebirgsgegend Kujuh als eine Uebungsstelle für die pflanzenoekologische Forschung. (Japanisch). Riichiro KÔKETSU und Makoto TAKENO-UCHI. (Bult. Sci. Faklt. Terk., Kjušu Imp. Univ. 2, 1926, 59-64.)

Die Gebirgsgegend Kujuh, die aus mehreren gruppenweise stehenden erloschenen Vulkanen gebildet ist und in der Nähe der Grenze zwischen Regierungsbezirken Oita und Kumamoto in Kyushu steht, besitzt in sich verschiedene Orte mit oekologischer Bedeutung. Man kann also verschiedene in der Nähe voneinander stehende Vegetationsphasen ohne Verkehrsschwierigkeit beobachten. In dieser Hinsicht kann dieses Gegend eine gute Uebungsstelle für Studenten der Pflanzenoekologie sein. Verf.

266. Über den Effekt der Anwendung der "Pulvermethode" für die Bestimmung des Stoffgehaltes im Pflanzenkörper. I. Bestimmung des Wassergehaltes im Pflanzenkörper in den ökologischen und vergleichend-physiologischen Studieng gebieten. (Japanisch mit einer deutschen Zusammenfassung). Riichiro KÔKETSU und Sadao YASUDA. (Bul. Sc. Fak. Terk., Kjušu Univ. 2, 1927, 200-208).

Der Wassergehalt im Blatt von 30 verschiedenen Pflanzen, deren Lebensbedingungen voneinander verschieden sind, ist hier vergleichend miteinander bestimmt. Die Resultate sind sowohl in Prozenten des Gesamt- und Trockengewichtes als auch in dem Gehalt pro Volumeinheit des Gewebepulvers gegeben, und zwar mit dem Zwecke die Frage zu diskutieren, welche Methode bei solchen Falle ökologisch und vergleichend-physiologisch einen zweckdienlichen Effekt erbringen kann. Als das Schlussresultat ist es nämlich gekommen, dass die "Pulvermethode" besser als die Trockengewichtsmethode selbst ist, während die Gesamtgewichtsmethode weit weniger zweckmässig als die zwei andere ist. Verf.

267. On the Mitosis and Fertilization in Sargassum Horneri Ag. (Japanese with an English résumé). Hiroshi KUNIEDA. (Bot. Mag. Tôkyô 40, 1926, 545-550, 22 figs.).

There are six simultaneous divisions of the nucleus in the antheridium as in *Fucus*, and the first division is heterotypic. The number of the haploid chromosomes is 16.

Three mitoses occur within the oogonium, resulting in eight nuclei and no cell wall is laid down between the nuclei. The first two divisions are meiotic and contain 16 haploid chromosomes.

The entire oogonium with eight nuclei is discharged from the conceptacle, being attached to the inner wall of the latter by a mucilaginous stalk. The spermatozoid enters the oogonium and fuses with one of the eight nuclei, while the other seven nuclei soon degenerate. In the segmentation divisions following fertilization, 32 diploid chromosomes were counted.

Author.

268. On the Wilting Disease of *Psidium Guyava*. (Japanese). Eiiti KUROSAWA. (Jour. Nat. Hist. Soc. Formosa **16**, 1926, 47-61).

Psidium Guyava is found wild in Formosa and much esteemed on account of its delicious fruits. It is often invaded by the so-called wilting disease: at first its leaves become discoloured, then yellow till finally they die and fall down. The author has studied the behaviour of the causal fungus, isolated it, and succeeded in making its culture on various nutrient media. The fungus belongs to the Melonconiaceae among the Fungi Imperfecti. It is a new species *Myxosporium Psidii* SAWADA et KUROSAWA. Its diagnosis is given in detail. It infects the roots and shoots of *Psidium Guyava*.

269. Experimental Studies on the Secretion of *Fusarium heterosporum* on Rice-plants. (Japanese). Eiiti KUROSAWA. (Jour. Nat. Hist. Soc. Formosa **16** 1926, 213-227, 1 pl.).

It is well known that the rice-plants invaded by *Fusarium heterosporum* undergoes among others an abnormal length growth of its vegetative parts.

The author has made the pure culture of this fungus, either in solid or liquid media, and got from it the water infusion. He has put the latter in a test-tube, etc. and sown there sterilized seeds of rice-plant or maize, and observed that in both plants leaves and especially their sheaths grow abnormally long and become pale green (on account of imperfect chlorophyll formation), and besides the growth of roots is much prevented. In view of such experimental results the author thinks that the cause of the above mentioned symptoms is due to a certain toxic substance secreted by the causal fungus. From the results of experiments with boiled infusion it may be inferred that the resistance of the toxic substance against the heat is rather great. Further comparative experiments with the infusion of various lines of *Fusarium heterosporum* and of certain similar fungi have shown that the abnormal length growth occurs only in the case of the former, and not in that of the latter. Infection experiments on various strains of rice-plants have also shown that the degree of susceptibility is different in different strains. It is likely that the rice-plants are not able to produce the antitoxin against the toxic substance secreted by the causal fungus.

270. Studies on *Plasmopara cubensis*. (Japanese). Eiiti KUROSAWA. (Jour. Nat. Hist. Soc. Formosa **17**, 1927, 18 pp.)

The author has made the detailed study of *Plasmopara cubensis*, the well-known a-sitic fungus on cucumbers. The following are some of the results of his studies.

Entries 263-270

Conidia come to germination in 1-1½ hrs. after the beginning of the drop-culture, rarely after 4 hrs. Each conidium produces generally 6-8 swarmspores, and in some cases even as much as 15. Each of the latter measures 11.5-12 μ \times 7-7.5 μ , and possesses two cilia at its ventral side, one of which is directed forwards and the other rearwards. The velocity of their motion is 60-80 μ per second, and its duration is 0.5-1 hr., and even 24 hrs. Swarmspores coming to rest become rounded; the germination begins after 1 hr., and the germ-tube may attain the length of 50-95 μ . Under 9°C and above 30°C no germination of conidia takes place, and 20°-22°C is the optimum temperature for this process. Conidia placed at 37°C during 12 hrs. are no more able to germinate. Conidia may be cultured on various nutrient media, on fresh leaves of cucumber, but not on boiled ones.

271. On the Spiral Structure of Chromosomes. Yoshinari KUWADA. (Bot. Mag. Tôkyô **41**, 1927, 100-109, 1 pl.)

The double nature of the chromatic spiral was clearly demonstrated in chromosomes in the metaphase of the heterotype division of fresh pollen mother cells of *Tradescantia virginica*, stained with neutral violet extra, and separation of the double spiral into two single ones was observed in the late anaphase. In the homotype division the spiral was found to be single. This paper discusses why the spiral is double only in the metaphase of the heterotype division, while in the homotype division as well as in the typical division it is single, and also whether the spiral is a natural structure or not. The bearing of the probable consequences of the separation of the double spiral into single ones on genetics has also been considered, with some model experiments with wires. Author.

272. The Influence of Hydrogen Ion Concentration on the Growth of the Seedlings of Some Cultivated Plants. Tsung-Lê Loo. (Bot. Mag. Tôkyô **41**, 1927, 33-41).

Preliminary report of the next No.

273. On the Mutual Effects between the Plant Growth and the Change of Reaction of the Nutrient Solution with Ammonium Salts as the Source of Nitrogen. Tsung-Lê Loo. (Japan. Jour. Bot. **3**, 1927, 163-203, 5 figs.).

274. On Intersexualism in *Arisaema japonica* Bl. Tokujiro MAEKAWA. (Japan. Jour. Bot. **3**, 1927, 205-216, 2 pls.)

275. The Compound Mycorrhiza of *Quercus pausidentata* Fr. Koki MASUI. (Mem. Coll. Sci. Kyoto Imp. Univ. Ser. B, **2**, No. 4, Art. 9, 1926, 161-187, 1 pl. and 41 figs.)

The author found two kinds of compound mycorrhizas, Forms A and B on roots of *Quercus pausidentata* Fr. (= *Q. sessilifolia*), and made the following descriptions upon them.

The compound mycorrhiza Form A is a cluster of numerous mycorrhizas, developed around an axial root, with the parts all bound together in one mass by an

enveloping mycelium. It develops from a large clavate primordium which is only a single ectotrophic mycorrhiza. This primordial mycorrhiza, on the one hand, continues its own growth longitudinally, and, on the other hand, gives off numerous side branches monopodially, each of which is then transformed into a mycorrhiza, all the while pushing forward and aside the fungous mantle of the primordium or the enveloping mycelium. Thus the compound mycorrhiza Form A is formed.

The compound mycorrhiza Form B is a tubercle formed by a cluster of stubby mycorrhizas enveloped by a common enveloping mycelium. Its primordium is at first a single short ectotrophic mycorrhiza, and develops by repeated dichotomous branching to a conspicuous size, pushing aside its primordial mantle or the enveloping mycelium.

The mycorrhizal fungus of Form B is *Boletus*, but that of Form A is unknown.
Author.

276. A Study of the Ectotrophic Mycorrhizas of *Alnus*. Koki MASUI. (Mem. Coll. Sci. Kyoto Imp. Univ. Ser. B, **2**, No. 4, Art. 10, 1926, 189-209, 1 pl. and 30 figs.)

The author describes in this paper ectotrophic mycorrhizas, two kinds in *Alnus japonica* S. et Z., three in *A. firma* S. et Z. var. *Sieboldiana* WINK. and one in *A. firma* S. et Z. var. *multinervis* REGEL.

In one of the mycorrhizas of *A. japonica* S. et Z., or *Cortinarius*-mycorrhiza, intercellular filaments enter the cortical cells as if they were endotrophic filaments; while in the other kind rhizomorpha-like hyphal bundles, which are given off from the surface of the mycorrhiza, contain numerous protein crystals which are fully demonstrated with ALTMANN'S staining method. A notable thing described about three kinds of mycorrhizas, white, yellow and black, of *A. firma* S. et Z. var. *Sieboldiana* is that there occurs the overlapping of different mycorrhizas among these three mycorrhiza-formers.
Author.

277. Comparative Studies on four Hyphomycetes pathogenic to Rice-seedlings. (Japanese). Isamu MATSUURA. (Jour. Microbiol. Soc. **21**, 1927, 1551-1572).

Four Hyphomycetes which are more or less hurtful to the germination of rice-plants as well as to the growth of their seedlings were isolated from certain rice seeds. All of them belong to the Dematiaceae among the Fungi Imperfecti. Their exact name is not yet settled, but it may be stated that one of them belongs to *Helminthosporium* and three others to *Brachysporium*. The author has performed their culture on rice-seedlings and various nutrient media, where their behaviour is more or less different, thus making them easily distinguishable from each other; and this is especially so in the medium containing asparagin and also in soya sauce agar medium. The optimum temperature for each of four fungi seems to be somewhat different; the maximum seems to be much higher than 32°C and the minimum somewhat lower than 10°C.

All of them are strongly pathogenic to the rice-seedlings, each being more or less different in its intensity from each other in this respect.

Entries 276-277

278. Ökologische Studien über die Sumpf- und Wassergewächse sowie ihre Formationen im Ogura-Teiche. (Japanisch). Shigeru MIKI. (Mitteil. aus Ges. für d. Studien der geschichtl. Denkmäler in Kyôtohu 8, 1927, 81-145, 25 Taf., 3 Textabbild.)

Ogura-Teiche nahe Kyôto beträgt 16 km im Umkreis und 929 hect. in der Fläche. Die dort befindlichen Phanerogamen sind aus 47 Familien, 96 Gattungen, 153 Arten und 3 Varietäten zusammengesetzt, was 85 % der Gesamtzahl der in ganzen Japan bisher aufgefundenen Wasserbewohnenden Phanerogamen entspricht. Der Verf. hat viele solche Pflanzen ökologisch studiert; es ist kaum möglich, einzelne Resultate davon in diesem kurzen Referat hervorzuheben.

279. A List of the Japanese Species of Mycetozoa. Kumakusu MINAKATA. (Bot. Mag. Tôkyô 41, 1927, 41-47).

An enumeration of all Mycetozoa found till now in Japan, mostly collected by the author himself with their localities, 169 species in all.

280. Untersuchungen über die Chromosomenzahlen bei einigen Viola-Arten. Yachiki MIYAJI. (Bot. Mag. Tôkyô 41, 1927, 262-268 mit Textabbild.)

Bei *Viola* vollzieht sich die meiotische Kernteilung bei Pollen- und Embryosackmutterzellen ganz normalerweise. Die Chromosomenzahl ist ziemlich variabel bei verschiedenen Arten, denn die Haploidzahl beträgt 6, 10, 12, 24 und 36(?). Diejenige Formen, deren Chromosomenzahl 10 ist, sind keineswegs systematisch untereinander nahe verwandt, ebensowenig ist es der Fall bei denselben mit 12 Chromosomen, woraus der Ver. meint, dass 10 und 12 die schon lange im Altertum abstammenden und voneinander unabhängigen Grundzahlen seien. *V. japonica*, welche 24 Chromosomen enthält, ist mit *V. phalacrocarpa* mit 12 Chromosomen systematisch nahe verwandt; nach der Verf.s. Ansicht seien beide aus einer gemeinsamen Mutterart mit 12 Chromosomen entstanden, und während bei *V. japonica* die Chromosomenzahl durch Längsspaltung verdoppelt hat, sie bei *V. phalacrocarpa* ganz dieselbe wie bei der Mutterart geblieben ist.

Starke Schwankung der Chromosomenzahl ist nicht selten von dem Polymorphismus begleitet. Das Artenreichtum von *Viola* mag der oben hervorgehobenen starken Schwankung der Chromosomenzahl zu verdanken sein. Auch begleiten oft Polymorphismus und Parthenogenesis miteinander, doch hat der Verf. den letzteren Vorgang niemals bei den *Viola*-arten nachgewiesen.

281. Genetic Experiments with Morning Glories. IV. (Japanese with an English résumé). Kiichi MIYAKE and Yoshitaka IMAI. (Bot. Mag. Tôkyô 40, 1926, 644-654, 2 figs.)

The paper deals with some double flowers of the Japanese Morning Glory. Double flowers due to petaloidy represents some conspicuous variation in their degree by the effect of a presumed modifier or modifiers. Double flowers of weak petaloidy give frequently the single flowers among their double-flowered progeny. Such single flowers are false singles, due to the fluctuating manifestation of the doubles. The segregating ratio of "Shishi-Botan" (proliferated "Shishi") seems to indicate the occurrence of weak linkage (about 45% of crossing over) between S_i and b_t . These

doubling factors, S_i , d_e and b_i , combining with each other produce some compound double flowers. "Tenaga-Botan" (proliferated flower with a long petiole) is segregated from the "parental stock" (heterozygous plant) in the recessive ratio.

Authors.

282. On the Inheritance of Double Flowers of the Japanese Morning Glory. Kiichi MIYAKE and Yoshitaka IMAI. (Proc. Imp. Acad. **3**, 1927, 167-168).

A résumé of No. 281.

283. Genetic Studies in the Opium Poppy (*Papaver somniferum* L.) II. On some Characters other than the Flower Colour. (Japanese with an English résumé). Kiichi MIYAKE and Yoshitaka IMAI. (Bot. Mag. Tôkyô **41**, 1927, 279-297, 5 figs.)

The bristles on the flower stalk are produced by duplicate factors, though they may exhibit some fluctuation in the manifestation of their phenotype and give more or less a higher ratio of the smooth stalk in the segregating generation. The crapy corolla behaves as a simple recessive to the normal condition, but its ratio in the segregating generation is almost always somewhat lower than the simplest requirement. The serrate petal acts as a dominant over the entire one, while its segregating ratio exhibited much variability in our experiments. We have some evidence to recognize the occurrence of modifiers affecting the degree of serration, though the F_3 examination showed the fact the main part of variability is due to the environmental condition. The double flower is a recessive character to the single, but its segregation is usually very low in proportion. The genetic nature of the double, therefore, is not simple. Besides the ordinary recessive double, we have met with a dominant one, which gives quite contrary result in crossing with a single.

Authors.

284. Inheritance in *Papaver somniferum*. Kiichi MIYAKE and Yoshitaka IMAI. (Proc. Imp. Acad. **3**, 1927, 169-170),

A résumé of No. 283.

285. On the Inheritance of Flower Color in *Sisyrinchium angustifolium*. Kiichi MIYAKE and Yoshitaka IMAI. (Jour. Coll. Agric., Imp. Univ. Tokyo **9**, 1927, 147-150, 1 pl.)

S. Japan. Jour. Bot. **1**, (24), No. 60.

286. On the Inheritance of Cosmos. (Japanese with an English résumé). Kiichi MIYAKE, Yoshitaka IMAI and Kiyoo TABUCHI. (Bot. Mag. Tôkyô **40**, 1927, 592-598.)

1. In the present paper, we mentioned the behavior of the following factors in *Cosmos*:

C, c—The factor **C** concerns the production of color in the flower.

S, s—In the coexistence of **C** and **S**, the flower assumes full coloration such as crimson or pink, but when the former factor is replaced by its recessive mate the result is a shaded flower.

- I, i**—In addition to **C** and **S**, the presence of **I** makes the flower crimson in color, while its recessive factor results in a pink flower.
- E, e**—The allelomorphs are responsible for the alternative conditions of the eye, dark and light.
- P, p** and **Q, q**—**P** and **Q** act complementally in the production of a "double-ring" pattern. Neither factor can produce the pattern by itself.
- Y, y**—The yellow pollen carries the factor **Y**, while the manifestation of white pollen is due to its recessive factor.
- B, b**—The factor **b** is responsible for the bracteoid of flower.

2. The factor **i** links with **p**, the frequency of crossing over being 6.13%
Authors.

287. Genetic Experiments with Cosmos. Kiichi MIYAKE, Yoshitaka IMAI and Kiyoo TABUCHI. (Jour. Coll. Agric., Imp. Univ. Tokyo **9**, 1927, 139-146, 1 pl.) S. No. 286.

288. Some Remarkable Instances of Improvement of Flower Characters in Cultivated Cherries. Manabu MIYOSHI. (Bot. Mag. Tôkyô **41**, 1927, 123).

Prunus serrulata LINDL. f. *Koshioyama-odora* nov. f. is a tree originally raised from the seed produced in 1910 by self-fertilization of *P. serrulata* LINDL. f. *communis* MIYOS. It differs from the mother tree by flowers which are much larger, more pinkish and decidedly fragrant. The author takes it for a case of progressive mutation. Another instance of mutation is found in *Prunus serrulata* LINDL. f. *purpurea-plena* nov. f. with double flowers of more than 10 petals; this tree was produced by the self-fertilization of *P. serrulata* LINDL. var f. *purpurea* MIYOS. with ordinary flowers.

289. Notes on Some Rare or Remarkable Plants. Manabu MIYOSHI. (Proc. Imp. Acad. **3**, 1927, 236-238).

Some plants recently proposed as natural monuments for preservation are described. Among the so-called chrysanthemum cherries characterized by possessing extraordinarily numerous petals the two following forms are described, *Prunus serrulata* LINDL. f. *juzukakezakura* nov. form. and *P. mutabilis* MIYOS. f. *ibozakura* nov. form. The clustered chesnut, *Castanea pubinervis* C. SCHN. var. *caudata* nov. var. distinguished by its possession of numerous cupules forming a long tail-like cluster is also described.

290. Experiments on Hybridization of various Strains of Solanum Melongena. (Japanese). Keizô NAGAI and Sigeitirô KIDA. (Japan. Jour. Genetics **4**, 1926, 10-30 with figs.)

The authors have studied the results of crossing of various strains of *Solanum Melongena* during five years, especially concerning the quantitative characters.

In F_1 -generation the result of heterosis is clearly seen, though its degree is different in different crosses. It is observed in the following characters: crop yield, the number of berries, the time of flowering (becoming earlier than in normal case), that of fruit-ripening (becoming earlier), the height of plants and extension, the number of branches, the number of spines in the stalk of berries, length of berries. Leaf length and breadth, etc. show no result of heterosis.

The mode of inheritance of berry colour, number of spines in the berry-stalk, diameter of berries, their form etc. is very complex and could not be definitely determined, but it is clear that a great number of genes act in combination.

291. Notes on Japanese Ferns V. Takenoshin NAKAI. (Bot. Mag. Tokyo **41**, 1927, 64-78).

This is a revision of the Cyatheaceae and Marattiaceae of the Japanese Empire.

The author arranged the names and synonyms of families, genera and species in accordance with the international rules of nomenclature.

The following are new to the Japanese Flora:—

1. *Cibotium Barometz* var. *Cumingii* CHRISTENSEN
2. *Cibotium assamicum* W. J. HOOKER
3. *Cyathea taiwaniana* NAKAI, sp. nov.
4. *Alsophila Fujiiana* NAKAI, sp. nov.
5. *Angiopteris d'Urvilleana* DE VRIES.

He changed the name of *Alsophila denticulata* BAKER to *Dryopteris Hancockii* NAKAI, because it is a species of *Dryopteris*, and there is already *Dryopteris denticulata* named by O. KUNTZE. Author.

292. Lespedeza of Japan & Korea. Takenoshin NAKAI. (Report of Forestry Experiment Station of Government General of Chosen No. 6, 1927).

This is a new classification of 27 species of Japanese and Korean *Lespedeza* belonging to 3 sections. The author has given Latin diagnoses, the photographs, analytical figures, and the habitats of all species and varieties. The following are new species, new varieties and new combinations.

1. *Lespedeza nipponica*, sp. nov.
2. *Lespedeza Thunbergii*, comb. nov.
3. *Lespedeza japonica* BAILEY var. *albiflora*, comb. nov.
4. *Lespedeza japonica* var. *angustifolia*, comb. nov.
5. *Lespedeza japonica* var. *gracilis*, var. nov.
6. *Lespedeza japonica* var. *intermedia*, comb. nov.
7. *Lespedeza japonica* var. *retusa*, var. nov.
8. *Lespedeza kiusiana* sp. nov.
9. *Lespedeza Maximowiczii* SCHNEIDER var. *elongata*, var. nov.
10. *Lespedeza Maximowiczii* var. *tomentella*, comb. nov.
11. *Lespedeza Maximowiczii* var. *tricolor*, comb. nov.
12. *Lespedeza cyrtobotrya* MIQUEL var. *pedunculata*, var. nov.
13. *Lespedeza cyrtobotrya* var. *longiramea*, var. nov.
14. *Lespedeza kawachiana*, sp. nov.

15. *Lespedeza nikkoensis*, sp. nov.
16. *Lespedeza retusa*, sp. nov.
17. *Lespedeza bicolor* TURCZANINOW var. *sericea* var. nov.
18. *Lespedeza setiloba*, sp. nov.
19. *Lespedeza rotundiloba*, sp. nov.
20. *Lespedeza robusta*, sp. nov.
21. *Lespedeza serpens*, nom. nov.
22. *Lespedeza cystoides*, comb. nov.
23. *Lespedeza cystoides* var. *divaricata*, var. nov.
24. *Lespedeza cystoides* var. *inschanica*, comb. nov.
25. *Lespedeza cystoides* var. *subsericea*, comb. nov.
26. *Lespedeza cystoides* var. *umbrosa*, comb. nov. Author.

293. Trees & Shrubs Indigenous to Japan Proper, Vol. I. Second Edition. (Japanese). Takenoshin NAKAI. (Publ. by Seibido Shoten, Nihonbashi, Tokyo, 1927). The author made careful comparative studies on the trees and shrubs of Japan proper, when he was in Europe and America and this led him to entirely rewrite the first edition. In the second edition 311 species, 157 varieties and 45 forms belonging to 22 families and 83 genera are described in Japanese. The book contains the illustrations on 323 zinc plates. The following novelties and new combinations are introduced with their scientific names and synonyms.

I. New plants and new sections:

1. *Ledum palustre* LINNAEUS var. *minus*
2. *Therorhodon camtschaticum* SMALL var. *barbatum*
3. *Menziesia ciliicalyx* MAXIMOWICZ f. *virescens*
4. *Menziesia lasiophylla* NAKAI var. *glabrescens*
5. *Rhododendron japonicum* SURINGAR var. *glaucophyllum*
6. *Rhododendron japonicum* f. *multifidum*
7. *Rhododendron Kaempferi* var. *purpureum*
8. *Rhododendron Kaempferi* var. *latisepalum*
9. *Vaccinium* Sect. *Ciliata*
10. *Vaccinium* Sect. *Bracteata*
11. *Vaccinium bracteatum* THUNBERG var. *lanceolatum*
12. *Vaccinium Smallii* A. GRAY var. *minus*
13. *Vaccinium* Sect. *Uliginosa*
14. *Vaccinium* Sect. *Præstantia*
15. *Palura paniculata* NAKAI var. *pilosa*
16. *Palura paniculata* NAKAI var. *pubescens*
17. *Palura paniculata* NAKAI var. *chinensis*
18. *Styrax* Sect. *Solenantha*
19. *Osmanthus hachijoensis*
20. *Ligustrum medium* FRANCHET & SAVATIER var. *psilorachis*
21. *Ligustrum kiyozumianum*
22. *Ligustrum tsusimense*
23. *Ligustrum rufum*
24. *Fraxinus borealis*

25. *Fraxinus Sieboldiana* BLUME var. *serrata*
26. *Fraxinus sambucina* KOIDZUMI var. *putescens*
27. *Fraxinus sambucina* KOIDZUMI var. *velutina*
28. *Syringa amurensis* RUPRECHT var. *macrophylla*
29. *Trachelospermum asiaticum* var. *intermedium*
30. *Trachelospermum asiaticum* var. *oblanceolatum*
31. *Callicarpa mollis* var. *ramosissima*
32. *Viburnum urceolatum* SIEBOLD & ZUCCARINI var. *procumbens*
33. *Viburnum phlebotrichum* SIEBOLD & ZUCCARINI var. *latifolium*
34. *Viburnum erosum* THUNBERG var. *lanceum*
35. *Abelia serrata* SIEBOLD & ZUCCARINI var. *glaberrima*
36. *Abelia serrata* SIEBOLD & ZUCCARINI var. *integerrima*
37. *Abelia Fargesii*
38. *Lonicera chrysantha* TURCZANINOW var. *crassipes*
39. *Lonicera tenuipes* NAKAI var. *tomentosa*
40. *Diervilla Weigelastrum*
41. *Diervilla sanguinea*
42. *Diervilla sanguinea* var. *leucantha*
43. *Pertya glabrescens* SCHULZ-BIP. var. *viridis*.

II. New combinations:

1. *Ledum palustre* LINNAEUS var. *groenlandicum*
2. *Rhododendron Fauriae* FRANCHET f. *Nemotoanum*
3. *Rhododendron Fauriae* var. *roseum*
4. *Xolisma elliptica*
5. *Xolisma formosana*
6. *Xolisma formosana* var. *pilosa*
7. *Xolisma Doyonensis*
8. *Hugeria japonica*
9. *Hugeria japonica* var. *ciliata*
10. *Bladhia lentiginosa*
11. *Rapanaea stolonifera*
12. *Palura paniculata* NAKAI var. *pallida*
13. *Bobua prunifolia* var. *Uiae*
14. *Bobua glauca*
15. *Ligustrum Ibota* var. *leiocalyx*
16. *Anodendron affine*
17. *Clerodendron Yakusimense*
18. *Nauclea orientalis* LINNAEUS var. *macrophylla*
19. *Gardenia jasminoides* ELLIS var. *angustifolia*
20. *Gardenia jasminoides* ELLIS var. *boninensis*
21. *Gardenia jasminoides* var. *grandiflora*
22. *Gardenia jasminoides* var. *Maruba*
23. *Gardenia jasminoides* var. *ovalifolia*
24. *Serissa japonica* THUNBERG var. *duplex*
25. *Serissa japonica* var. *pleniflora*
26. *Abelia serrata* SIEBOLD & Zuccarini var. *Ruchwaldi*

27. *Abelia serrata* var. *gymnocarpa*
28. *Abelia serrata* var. *tomentosa*
29. *Lonicera caerulea* LINNAEUS var. *emphylocalyx*.

III. New names :

1. *Rhododendron Makinoi* TAGG for *Rhododendron stenophyllum* MAKINO (non HOOKER)
2. *Vaccinium Usunoki* NAKAI for a part of *Vaccinium Buergeri* MIQUEL
3. *Psychotria boninensis* NAKAI for *Psychotria macrophylla* HAYATA (non RUIZ & PAVON).

Above all, 100 species and varieties are newly added. and a number of erroneous names are corrected. Author.

294. On the Causal Organism of Tobacco Wilt. (Japanese with an English résumé). Kakugorô NAKATA. (Jour. Sc. Agric. Soc. No. **294**, 1927, 185-216).

The investigations on the tobacco wilt were done on the materials from Japan proper, Korea and U.S.A. Of the wilting and blackening of stems, leaves, roots, which are the characteristic symptoms of the disease the former is due to the action of a toxic substance produced by the causal organism, while the latter is caused by the action of tyrosinase on tyrosin which is produced by its decomposing action on albumen of the host plant. Experiments have shown that the shade of color and the time required for blackening not only depend upon the amount of albumen but also on that of sugar content in the nutrient media and the growth intensity of the organism: the larger amount of sugar in the nutrient media and the luxuriant growth of the organism retard or hinder the blackening.

The causal organism is a *Bacillus* with the index number 222.2223332. There are two forms: the one develops in agar culture an irregular, fluidal iridescent, tar-black colony and liquefies gelatine, while in the other the colony is circular, homogeneous, opalescent, dirty whitish or brownish with no liquefaction of gelatine. The organism produces the acid and coagulates casein in the culture in fat-containing milk, but the alkali in that in milk not containing fat. It grows well in COHN's solution when a relatively large amount of inoculum is transferred. For the continual growth of the organism in nutrient media a certain substance from natural media is necessary, such as potato, milk; as such substance is contained in the organism itself the continual growth may take place, when the larger amount of inoculum is transferred to the artificial media. Tolerance of the organism to the acid and temperature depends upon the kind of media in which it is cultured.

All characters coincide with those of the original culture of *Bact. solanacearum* SMITH, hence this name may be applied to our organism. The author was not able to get *Bac. Nicotianae* proposed by UYEDA as the causal organism of tobacco wilt in Japan, and he is inclined to think that the description of *Bac. Nicotianae* might not have been drawn from one organism, but probably from the contamination with *Bac. aroideae*. The characters of *Bac. Sesami* (*Ps. Sesami*) described by MALKOFF are the same as those of *Bac. solanacearum* above mentioned, which has also been found naturally in *Sesamum indicum* in Japan and Korea.

295. Hollow Stalk of Tobacco and its Causal Organism. (Japanese). Kakugorô NAKATA. (Agric. and Hortie. **2**, 1927, 11-16).

The "hollow stalk" disease invades chiefly the stems of tobacco-plants, but also leaves and roots. In any case the medullary part goes to putrefaction earlier than the cortical and disappears, so that the hollow cavity results, hence the name of the disease. The author could isolate its causal organism, and proved its pathogenicity in virtue of the infection experiments. The index number of the organism is 221.-222.3032, and corresponds to *Bacillus aroideae* first observed by TOWNSEND. Its behaviour on several nutrient media and its various physiological characters were studied.

296. Studies on Sclerotium Rolfsii Sacc. Part 4. The Size and Shape of the Sclerotia and their Relation to the Strains of the Fungus. (Japanese). Kakugorô NAKATA. (Bult. Sc. Fak. Terk., Kjušu Imp. Univ. **3**, 1927, 169-189).

On account of the polyxeny and the scarceness of spore-formation the identification of various strains of the fungus *Sclerotium Rolfsii* is based chiefly upon the shape and size of its sclerotia. They are very variable according to the environment, and the author has studied the relation between them.

Both the size and shape of sclerotia are very variable according to the chemical nature, concentration and reaction of culture-media as well as the temperature. The sclerotia reveal their real shape when the culture in the very nutritive media at about pH 5.4 is maintained under the optimum temperature 32°C. Otherwise the sclerotia become more or less spherical.

The influence of the environment upon the shape and size of sclerotia is however different in different strains and characteristic of each, so that the right comparison of different strains can be done when their culture is performed under the same environmental conditions. Furthermore, the writer undertook to find the best conditions, under which each strain may reveal its real characteristics. From the results of his experiments the culture on the standard Koji extract at pH about 5.4 under the temperature 30°C was found to be most suitable for the purpose.

297. On the Variability and Inheritance of the Resistance of the Rice-plants against the Rice Blast Disease. (Japanese). Sadao NAKATOMI. (Japan. Jour. Genetics **4**, 1927, 31-38).

In order to study whether the resistance of the rice-plants against the rice blast disease is variable in various strains a number of them were cultivated and infected with the spores of the causal fungus. The positive results of the author's experiments in 1913 and 1914 are shown in a table. It is rather remarkable that some foreign strains, for example, those from India, Philippines, Java were found to be most resistant. It was further observed in the author's experiments during three successive years that the disease was far less prominent in 1913 than in 1912 and 1914. The author thinks that the fact is due to the dryness of 1913, especially to long dry days immediately after the infection. To confirm the latter hypothesis the following experiments were made: a certain number of infected seedlings were placed in two separate rooms which were maintained under the same temperature,

but under different moisture (in average 94.0 and 78.4 humidity respectively); the author has calculated the number of diseased spots on the plants of both series, and found that it was far larger in those placed in more humid room than in those placed in less humid one.

It is often stated that the abundance of nitrogenous manure favours the development of the disease; the author has confirmed this statement in virtue of his experiments.

Experiments were done also about the inheritance of the resistance against the rice blast disease. The result is that this power is inherited according to MENDEL's law.

298. Studies in *Plasmopara Halstedii*. II. Makoto NISHIMURA. (Jour. Coll. Agric., Hokkaido Imp. Univ. **17**, 1926, 1-61 with 5 plates).

Plasmopara Halstedii, parasitic on the young seedlings of *Helianthus annuus*, is able to develop, not only on leaves, but also on roots and underground stems, where the formation and presence of mycelium and conidiophores were observed by the author. The conidia formed on the underground organs are little larger than those formed above ground, and this may be due, not only to the abundant supply of nourishment, but also to some external conditions, such as great humidity, lack of light, constant temperature in the underground. While each aerial conidium produces about 8 zoospores, subterranean one can produce sometimes more than 40.

The results of cytological studies are briefly as follows. The coenocentrum which is composed of small granules surrounded by dense cytoplasm appears in the center of the oogonium, and the female nucleus is attached to it before fertilization. The vacuoles in the periplasm gradually fuse to each other, thus increasing in size and diminishing in number. The cyto- and kinoplasm accumulate around the vacuoles. The nuclear division occurs in the oosphere near where its wall is soon to be formed; daughter-nuclei arrange themselves mostly in the line of demarcation between periplasm and oosphere. After the nuclear division is finished the oosphere wall becomes visible. A monocyte (receptive papilla) is developed on the side where the oogonium comes in contact with the antheridium. Many nuclei in the oosphere degenerate, and one nucleus remains in its center. The fertilizing tube from the antheridium attains the oosphere through the monocyte, one or two male nuclei are discharged, and the fertilization takes place. At the opening produced by the penetration of the fertilizing tube the wall closely adheres to the latter, so that no intercourse between periplasm and oosphere can occur.

In the germinating conidia the nuclei migrate outwards, till their apical ends reach the surface of the protoplasmic mass therein contained; these ends take on a beak-like appearance and become blepharoplasts, from which the cilia of zoospores sprout out. The protoplasmic mass of each conidium is divided by cleavage furrows and gives rise to a number of zoospores. The cilia formation takes place when the zoospores are yet within the conidia, and they are still connected by cilia, even after germination of conidia.

Two or three haustoria may be produced within a host-cell. Their neck is short and thick, in contrast to long and thin one in the Erysiphaceae. At the inception of a haustorium a nucleus usually remains near its point of entrance.

Centrosomes are seen in conidia, zoospores, mycelia, oogonia and antheridia. Blepharoplasts, from which the cilia of zoospores sprout out, are derived from the centrosomes.

299. On the Asexual Reproduction of *Aegagropila Sauteri* (Ness) Kütz. (Japanese with an English résumé). Makoto NISHIMURA and Risuke KANNO. (Bot. Mag. Tôkyô **41**, 1927, 432-438, 2 pls.)

In *Aegagropila Sauteri* (NESS.) KÜTZ. in its very earliest stage there is no differentiation into a cauloid and a rhizoid part, and the thallus grows in compact spheres or cushions. The lower parts of the thalli (i. e., the oldest segments of the main axis) gradually die, so that the branches are set free from the base upwardly. Usually such free thalli are found floating in great quantities in Akan-Lake in Hokkaido. As it usually occurs in vegetative propagation, each separate portion is able to grow into a complete new thallus.

In addition to such vegetative propagation asexual reproduction was found in summer, in the individuals brought from Akan-Lake. It takes place by biciliated swarm-spores formed in large numbers, and especially very large numbers are formed in the terminal segment.

Swarm-spores may arise in almost any segment (i. e., apical or median segment) and they escape through an opening which is made by a complete dissolution of the cell-wall at some point near the apex of the segment. In certain cases it was observed that germination of the swarm-spores took place in the segment since there was no opening formed.

Swarm-spores may occur simultaneously in various segments of the same filament. The number of swarm-spores is variable, for instance, in the apical segment there are usually many swarm-spores, but in the median segment sometimes fewer in number. In that case, the spores in the apical segment are smaller than those in the median segment.

The asexual swarm-spores are pear-shaped and possess two cilia of equal length. The spores are therefore motile and are of an intense green color, are completely filled with cytoplasm, and possess one nucleus, a visible red eye spot, a few bowl-shaped chloroplasts and food-reserves. The spores are positively phototropic, their apical end being towards the source of light.

Evidently the swarm-spores germinate only after a period of rest, and each produces a new filament directly.

Authors.

300. Temperature Relations to the Growth of Graminicolous Species of *Helminthosporium* I. Yosikazu NISIKADO. (Ber. Ôhara Inst. landw. Forsch. **3**, 1927, 349-377 with 4 pls.)

The present paper presents the results of the author's studies on *Helminthosporium turcicum* and *Maydis* about the relation of temperature to their mycelial growth, the colouration of colonies, conidia formation, shape and size of conidia, development of perithecia, pathogenicity and the death points.

301. Studies on the Rice Blast Disease. Yosikazu NISIKADO. (Japan. Jour. Bot. **3**, 1927, 239-244).

302. Comparative Studies on the Helminthosporium Diseases of Rice-plants in the Regions of the Pacific Coasts (Japanese). Yosikazu NISIKADO and Chûichi MIYAKE. (Agric. Studies **10**, 1927, 21 pp. with 4 pls.)

The culture of strains of *Helminthosporium Oryzae* BREDÁ et HAAN from Japan, U.S.A., Philippines and Java was done, and the comparative studies of their morphological as well as physiological characters were performed. Though all strains belong to one and the same species they were nevertheless found to differ somewhat in their morphological (e. g. shape of conidia) as well as physiological characters. The shape of disease spots and the pathogenicity of all strains seem not to be different from each other. The authors think that the American strains, on account of the degree of differentiation considerably different from the other strains may be looked up as a special race.

303. Ueber den Einfluss der Aussenbedingungen auf das Blütenöffnen der Reispflanzen IV. Einfluss des Regens und Sturmes (Japanisch). Yakiti NOGUTI (früher KOBAYASI). (Jour. Sc. Agric. Soc. No. **293**, 1927, 177-184 mit Textfig.)

Die Gesamtzahl von sich öffnenden Blüten ist ganz gleich beim Regen und Sturm wie beim schönen Wetter, nur im ersteren Falle wird der Eintritt des Vorganges um etwas 2-3 Uhr verspätet. Das Aufspringen der Antheren und die Bestäubung werden etwas verhindert, doch ist der Fruchtungsprozent gar nicht vermindert. Bei Regen und Sturm ist natürlich die Temperatur etwas niedriger als beim schönen Wetter und die Luft fast ganz gesättigt, was, wie schon früher von Verf. gezeigt worden ist (s. Japan. Jour. Bot. **3**, 1926, (5), Nr. 23), die Zahl der sich öffnenden Blüten bedeutend vermindern muss. Die Tatsache, dass trotzdem sie nicht besonders erniedrigt wird, ist nach der Verf.s Ansicht darauf zurückzuführen, dass beide Regen und Wind durch Erschütterung das Blütenöffnen beschleunigen. Der Oeffnungswinkelgrad von beiden Spelzen ist beim schlechten wie beim schönen Wetter nicht besonders verschieden.

Verf.

304. Experiments on Chrysanthemum sinense, Sabin. var. spontaneum, Mak. Sigeroku NOHARA. (Bot. Mag. Tôkyô **41**, 1927, 129-141, 8 text-figs.)

A large number of stocks of *Chrysanthemum sinense* var. *spontaneum* which were originally derived from one single stock were cultivated during 1923-25 chiefly at Mito, but partly at Hota which is much warmer than Mito. The number of ray-flowers was counted and their length measured, and the means, standard-deviations, as well as coefficients of variation were calculated on more than thousand stocks. The correlation table between the number and the length of ray-flowers was made. It was found firstly that the correlation coefficient was very insignificant and secondly the number of ray-flowers (mean=17) and their length (mean=16½ mm) do not undergo any considerable modification, even cultivated in different localities differing in temperature and soil, and also in different years.

305. The Pungent Principles of Ginger. IV. Synthesis of Shogaol. Hiroshi NOMURA and Shunji TSURUMI. (Proc. Imp. Acad. **3**, 1927, 159-160).

306. On the Structure of *Diplazium esculentum*, (Retz.) Sw. Yudzuru OGURA. (Bot. Mag. Tôkyô **41**, 1927, 172-180, 4 figs.)

The anatomical structure of a tree-fern *Diplazium esculentum* belonging to the Polypodiaceae was studied. The stem has the dictyostele with medullary bundles, while the petiole has double bundles which fuse into one at a higher part. The construction of the stelar ring, the mode of parting of leaf- and root-traces, the presence of brown sclerenchymatous masses and the histological structure of the vegetative organs show the normal Polypodiaceous type.

There are two types about the origin of the medullary bundles, the one originating independently in the pith and the other by internal thickening of the meristele. In both cases their upper ends join with the leaf-traces. The former type is normally found in the adult plant and the latter in the young, indicating that the former or the Cyathean type has been derived from the latter or the Polypodian type. Author.

307. Comparative Anatomy of Japanese Cyatheaceae. Yudzuru OGURA. (Jour. Fac. Sc. Imp. Univ. Tokyo **1**, 1927, 141-350, 74 figs.)

The present paper contains the detailed description of the anatomical structure of a number of Japanese tree-ferns which have been already preliminarily published by the author several times before. The tree-ferns treated of include *Cyathea spinulosa*, *Alsophila Ogurae*, *A. aculis*, *A. Bongardiana*, *Cibotium Barometz*, *Alsophila* from Formosa and Loochoo. (S. Japan. Jour. Bot. **3**, (19), (35), (65), (66)).

308. On Changes of Osmotic Concentration in Certain Plants. Ichirô OHGA. (Bot. Mag. Tôkyô **40**, 1926, 587-591).

The author has studied the variation of the osmotic pressure in leaves and root-hairs of certain plants, such as broad bean, wheat, buckwheat, *Coleus*. The method of plasmolysis by sucrose was used throughout the experiments. It was found that the osmotic pressure differs in different stages of growth in one and the same plant. The restriction of water supply causes an increase in the osmotic concentration: the maximum increase of osmotic pressure in roots observed by the author was up to 0.8-1.0 M. sucrose. Furthermore, some plants grown in high sucrose concentration continued to live in its 0.8-1.0 molecular solution, in which case the external force required to induce the permanent wilting should be more than 18.7 atmospheres.

309. A Study of the Ancient but still Viable Fruit of the Indian Lotus found in the Peat Bed near Pulantien, South Manchuria. Ichirô OHGA. (Dairen, 1927, III+107 pp. with 8 pls.)

The paper is a collection of the author's several articles concerning the ancient fruit of Indian Lotus found in Pulantien, South Manchuria already published in the journals, such as Bot. Mag. Tôkyô, Japan. Jour. Bot. and Amer. Jour. Bot.

310. On the Age of the Ancient Fruit of the Indian Louts which is kept in the Peat Bed in South Manchuria. Ichirô OHGA. (Bot. Mag. Tôkyô **41**, 1927, 1-6, 1 fig.)

The topograph of the Pulantien Fasin in South Manchuria, where the ancient Lotus fruits are found is described. The peat bed is about 4 sq. km, and in this whole area they are found located at the depth of about 1/3 to 2/3 m.

311. Supramaximal Temperature and Life Duration of the Ancient Fruit of Indian Lotus. Ichirô OHGA. (Bot. Mag. Tôkyô **41**, 1927, 161-171, 5 figs.)

According to the author's view the remarkable longevity of the ancient Lotus fruits in Pulantien, South Manchuria, should be ascribed to the presence of hard seed-coats as well as the nature of protoplasm in the embryo. The death of seeds is due to the coagulation of proteins in protoplasm which depends upon the temperature and moisture, so that if the latter remains constant, the temperature should be the sole agent for inducing the death of seeds. The author has performed a series of experiments for studying this effect of temperature. It was found that there is a gradual decrease in the rate of germination with increased time of heating and a fruit kept at a higher temperature for a short time and one kept at a lower temperature for a longer time develop the similar features. Among others it was observed that at 120°C the viability of seeds was lost in 10 min. Furthermore, the author has found that the temperature-duration curve showed a logarithmic nature, just as in the experiments of LEPESCHKIN on *Beta* and *Tradescantia*, so that his time-temperature formula $T = a - b \log Z$ was also here applicable. From the actual values found in virtue of his experiments as well as from those calculated by the logarithmic formula the author thinks that he might well predict the longevity of the Lotus fruits kept in the soil under 30° to -10°C and in about 10°C in average to be some thousand years.

312. Cytological Studies on Prunus. (Japanese with an English résumé.) Sakuichi OKABE. (Bot. Mag. Tôkyô **41**, 1927, 398-404 with figs.)

The chromosome number in different species of *Prunus* was counted. Usually they show the diploid number 16, but three species in the subgenus *Padus* were proven to be tetraploid (32). Furthermore, it is remarkable that about one-third among thirty double-flowered garden varieties of *P. serrulata* LINDL. reveal to be triploid (24) in somatic division; in these plants 8 trivalent chromosomes usually appear in the first nuclear division of pollen-mother-cells.

313. On Campylaephora hypnaeoides J. Ag. Kintarô OKAMURA. (Bot. Mag. Tôkyô **41**, 1927, 365-368, figs.)

Campylaephora is a genus first established by J. AGARDH in 1851 to distinguish from *Ceramium* and then adopted by Fr. SCHMITZ. The author has studied the structure of the fronds, tetraspores and cystocarps of *Campylaephora hypnaeoides* J. AG. and could hardly find any significant distinction from *Ceramium*, so that he came to adopt the name *Ceramium hypnaeoides* (J. AG.) OKAM. instead of *Campylaephora hypnaeoides* J. AG.

The mode of propagation of this alga is described. (S. Japan. Jour. Bot. **1**, (45), Nr. 111).

314. Weitere Studien über die moderierende Rolle der organischen Salze und des Phosphats bei der Kultur von *Aspergillus niger*. Tetsu SAKAMURA. (Japan. Jour. Bot. **3**, 1927, 245-265 mit 2 Abbild.)

315. Fixierung von Chromosomen mit siedendem Wasser. Tetsu SAKAMURA. (Bot. Mag. Tôkyô **41**, 1927, 59-64, 1 Taf.)

Die "Fixierung mit siedendem Wasser" ist nach dem Verf. keineswegs leicht und einfach. Seine durch lange Erfahrung gewonnene Methode lautet in seinen eigenen Worten wie folgt: "Man bereitet siedendes destilliertes Wasser im Becherglas. Ein Objektglas wird auf Körperwärme erwärmt; Pollenmutterzellen werden aus einigen Antheren darauf herausgedrückt. Man setzt eine mässige Menge (nicht zu viel!) von siedendem Wasser zu, und bedeckt dann das ganze möglichst schnell mit einem etwas erwärmten Deckglas, um es darauf sofort über einer kleinen Gasflamme etwa zweimal schwach sieden zu lassen. Allzu starkes Sieden ist zu vermeiden, damit die Pollenmutterzellen gut im Mediumwasser unter dem Deckglas erhalten werden. Objekt- und Deckgläser und andere verwendete Glasartikel müssen möglichst alkaliarm sein."

In den nach dieser Methode fixierten Pollenmutterzellen von *Tradescantia virginica* konnte der Verf. sehr deutlich die spiralige Struktur der Chromosomen nachweisen, welche ohne Zweifel eine natürliche Struktur sein muss; es ist klar, dass dabei die Grundsubstanz mehr oder minder aufgelöst und der spiralige Teil übrig geblieben ist. Die Bilder sind durch die sehr gut gelungenen Mikrophotographien illustriert. Ob die Methode auf die anderen Objekte anwendbar sind, und zwar mit ebenso guten Erfolgen, ist noch zu untersuchen.

316. On the Morphological Significance of Seed-bearing Leaves of Ginkgo. Michiharu SAKISAKA. (Japanese with an English résumé). (Bot. Mag. Tôkyô **41**, 1927, 273-278, 1 pl.)

By studying the seed- or anther-bearing leaves of *Ginkgo biloba*, and comparing them with the normal flowers, the writer came to the following conclusions:

1. Seed- and anther-bearing leaves are senile forms.
2. The so-called collar of seed and knob-like terminal scales of anther are the residual portion of the lamina of the reproductive leaf.
3. Seed-bearing leaves are homologous to normal seeds.
4. Normal seed stalk is a floral axis.
5. Ovule and anther are phyllome organs.

Author.

317. On an Abnormal Type of Germination of Rice Seeds under Reduced Air Supply. (Japanese with an English résumé). Takashi SASAKI. (Jour. Sc. Agric. Soc. No. **288**, 1927, 461-469, 101-102 with figs.)

The condition of reduced air supply was secured either by displacing air in KITAZATO's bottles by hydrogen or withdrawing air in ERLÉNMEYER's flasks by an aspirator to the pressure of 33 mm. In places of such reduced air supply rice seeds present the abnormal type of germination: the development of the coleoptile is unusually conspicuous and colourless, foliage leaves never grow to the length of more

than a few mm. and even in some cases do not develop at all; tiny foliage leaves remain hidden at the base of the coleoptile in quite a rudimentary condition, though, as well known, normally they emerge vigorously through the small slit at the tip of the coleoptile; the radicle develops very poorly, and sometimes even does not emerge at all.

318. On the Preservation of the Pollen of Cereals. Takashi SASAKI. (Proc. Imp. Acad. **3**, 1927, 191-193).

A comparative study on the longevity of pollen of barley and maize was done by preserving it under different degrees of humidity and seeing the results of actual pollination of stigmas with such pollen. The relative humidity varying from 20-80 % as well as the absolute dryness were secured by the use of sulphuric acid of various concentration in the dessicators. In virtue of a series of experiments it was found that 40 % relative humidity gives the best results for barley, for then its pollen remains fertile for the longest time and gives the highest percentage of seed-formation. For maize 50 % humidity is best. (S. Jap. Jour. Bot. **3**, (22), No. 67.—Ed.)

319. Erysiphaceous Genera in Formosa, considered in their Conidial Generation. (Japanese). Kanekichi SAWADA. (Rpt. Dept. Agric. Res. Inst. Formosa **24**, 1927, 55 pp. with 3 pls.)

The classification of the fungi belonging to the Erysiphaceae is based generally on their ascigerous generation. Since in the tropical and subtropical regions they remain generally in their conidial stage and proceed very rarely to the ascus formation, their identification is there often hardly possible. In order to obviate this inconvenience the author has published in 1914 the classification of various genera of the Erysiphaceae according to their characters in the conidial generation.

In the present paper he has published a classification of several species of *Erysiphe* found in Formosa according to the characters of conidial apparatus. The genus is divided into three groups: 1. that with the conidiophore, equally thick throughout its whole length, produced on the upper side of the epiphytic mycelium and perpendicular to the host's organ, 2. that with the conidiophore as in 1, but swollen at its base, and 3. that with the conidiophore produced at the lateral side of the epiphytic mycelium and curved at its base, so as to be perpendicular to the host's organ. The fungi belonging to the above three groups are described in detail and illustrated. A number of infection experiments were made. The measurement of the size of conidia was also performed, and this always on fresh ones, because the conidia taken from dried specimens are much deformed and will give no exact data.

320. On the Putrefaction Disease of Seedlings of *Antirrhinum majus*. (Japanese). Kanekichi SAWADA and Chi-Chang CHEN. (Jour. Nat. Hist. Soc. Formosa **16**, 1926, 199-212).

The disease attacks the roots and the parts adjacent to them of the seedlings of *Antirrhinum majus* and induces their death. The causal organism is a new fungus, *Pythium spinosum* SAW. It produces conidia and oospores; conidia do not give rise to swarmspores. The culture on various media was done. Infection experiments

have proven that the fungus is pathogen to many other plants, such as cucumber, radish, onion, etc., etc. The optimum temperature for its growth is 30°C. Several methods of control are proposed.

321. "Mompa"-disease of Oranges. (Japanese). Kanekichi SAWADA and Eliiti KUROSAWA. (Notes from Dep. Agric. Res. Inst. Formosa **46**, 1927, 21 pp. and 2 pls.).

The surface of branches, leaves, fruits etc. of orange-trees which suffer under the "Mompa"-disease is covered with a crust consisting of mycelial bundles which look like hard hairs of brown or purple brown colour. This prevents the healthy growth of the hosts and cause their ultimate death. The crusts may easily be detached and propagated by certain scale insects. The causal organism is a fungus with no spore-formation. It belongs to the genus *Anthina* among the Fungi Imperfecti; the authors have given it the new name *Anthina Citri* SAW. Various methods of control are given.

322. Über Störungen der meiotischen Teilungen durch niedrige Temperatur. Naomasa SHIMOTOMAI. (Bot. Mag. Tōkyō **41**, 1927, 149-160, 15 Textfig.).

Durch die Einwirkung der niedrigen Temperaturen während gewissen Zeit-dauern (z. B. 5-7-stündige Abkühlung bis auf 0°C) hat der Verf. die unregelmässigen Kernteilungen in den Pollenmutterzellen von *Liriope* and *Scilla* entstehen lassen können. Die Resultate solcher Kernteilungen sind die Produktion der abnormalen grossen und kleinen Pollenkörner, welche keimungsfähig sind und in günstigen Fällen sogar die Befruchtung erzielen können.

323. Microsporogenesis in *Oenothera sinuata*, L. Yosito SINOTÔ. (Bot. Mag. Tōkyō **41**, 1927, 225-234, 1 pl.)

The present paper contains the results of the author's cytological studies on the microsporogenesis of *Oenothera sinuata* extending from the synaptic stage till the formation of pollen tetrads. In the synopsis he could find no evidence whatever of parallel threads or pairing of thicker portions of the threads, which is contrary to what for instance BOEDJIN has seen in *O. Lamarckiana*. The threads become later differentiated into the thicker and thinner portions, of which the former grow up into univalent chromosomes. In late prophase we observe a large closed circle consisting of 14 chromosomes which are joined end-to-end to one another, so that the mode of gemini-formation is telosyndetic instead of being parasyndetic. In metaphase the chromosomes become arranged in the equatorial plate, and normally alternate chromosomes in each circle pass to the same pole. The haploid and diploid chromosome numbers are 7 and 14 respectively. Pollen tetrads are formed by the mode of furrowing.

324. A Cytological Study on the Pollen Sterility in *Solanum tuberosum* L. Isamu STOW. (Proc. Imp. Acad. **2**, 1926, 426-430, 7 figs.; Japan. Jour. Bot. **3**, 1927, 217-238, 1 pl. and 48 figs.)

325. Some Observations on the Meiosis of the Pollen Mother Cells of *Carica papaya*, *Myrica rubra*, *Aucuba japonica* and *Beta vulgaris*. Toranosuke SUGIURA. (Bot. Mag. Tôkyô **41**, 1927, 219–224, 1 pl. and 1 textfig.)

The cytological studies on the microspore-formation of four species enumerated in the title of this paper have shown that the end-to-end connection of univalent chromosomes is visible in the prophase of the first meiotic division, so that the mode of gemini-formation is telosyndetic. The haploid number of chromosomes is 8 for *Myrica*, 9 for *Carica* and *Beta*, and 16 for *Aucuba*. No sex-chromosomes were found in the male of *Carica*, *Myrica* and *Aucuba*. Pollen-tetrads are formed by the mode of furrowing.

326. Untersuchungen über die Sporenkeimung von *Saccharomyces* I-II. (Japanisch). Kinsi SUMINOE. (Zeit. Gärungslehre **4**, 1926–7, 24 S. m. 13 Fig. und 18 S. m. 41 Fig.)

Teil I enthält hauptsächlich die von dem Verf. schon an anderem Orte publizierten Sache (s. Japan. Jour. Bot. **3**, (38), (67)), doch etwas ergänzt und berichtigt. Unter den neu hinzugefügten Sachen mag das folgende einfache Verfahren für die Beschleunigung der Sporenkeimung von Interesse sein: die Hefepräparate werden einer Nacht unter 9°–13°C und beim nächsten Morgen unter 25°–30°C gestellt, woraus die Keimung nach 2–3 Stunden, spätestens nach 7–8 Stunden beginnt.

Im II Teile erwähnt der Verf. die *Saccharomyces*arten und -rassen, von denen er neulich die Sporenkopulation hat nachweisen können, nämlich, 11 Rassen von *S. Sake*, *S. Shaoshing*, Logos Hefe (*S. brasiliensis*), 9 amerikanische Weinheferassen, französische Champagnehefe, 1 japanische Weinheferasse. Die Sporenkopulation geschieht immer innerhalb des Askus, niemals nach ihrem Zerreißen. Bei der Kopulation ist das folgende selten eintretende Phänomen von Interesse: eine von zwei kopulierenden Sporen nimmt immer an Grösse ab, bis sie ganz verschwindet, während die andere wächst zu und zur Keimung kommt, was an die Kopulation der männlichen und weiblichen Gameten von verschiedener Grösse erinnert. Das Verhältnis der kopulierenden zu den einzeln keimenden Sporen ist nach den äusseren Umständen sehr variabel, so z. B. nimmt es mit der besseren Ernährung zu. Verf.

327. Kopulationserscheinungen der Sporen bei *Zygosaccharomyces* I. (Japanisch). Kinsi SUMINOE. (Zeit. Gärungslehre **4**, 1927, 6 S., 3 Abbild.; Jour. Sc. Agric. Soc. No. **292**, 1927, 85–90, 3 Abbild.)

Der Verf. unterscheidet sechs Keimungsweise von *Zygosaccharomyces*sporen, von denen eine dieser Gattung eigentümlich ist: die Sporen keimen innerhalb des Askus, gerade gegenüber seinem Kopulationsfortsatz, sodass die Keimschläuche zuletzt bis zum anderen Askus eindringen. Die Sporenkopulation wurde, wenn selten, an *Z. Barkeri* und *Z. Saké* beobachtet. Bei gewissen Hefen, von denen die Fähigkeit der Sporenbildung sehr schwach ist, kann man eine ziemlich reichliche Sporenproduktion veranlassen und zwar durch die Gipsblockmethode, wenn man statt des Wassers die Zuckarlösung oder das Kojiwasser gebraucht, was der zur Zeit herrschenden Meinung entgegengesetzt ist, wonach der Nahrungsmangel eine Bedingung der Sporenbildung ist. Verf.

328. Über die Nachreifungshefepilze japanischer Sake. I-II. (Japanisch). Kinsi SUMINOE. (Zeit. Gärungslehre **4**, 1927, 5. S. und 4 S. m. Fig.; Jour. Sc. Agric. Soc. **292**, 1927, 91-96 und 97-100 m. Fig.)

Aus dem schwarzen Niederschlage japanischer Sake hat der Verf. eine neue *Zygosaccharomyces*-art bekommen, welche zur Nachreifung in irgend einer Beziehung steht und welche *Z. Sake* n. sp. genannt wird. Zellen gewöhnlich elliptisch, $4-11 \mu \times 4-8 \mu$, wächst ziemlich gut bei Kojiagarschräggkultur, kann Dextrose, Lävulose, Saccharose usw., aber nicht Laktose, Mannit, Rhamnose, Inulin usw. vergären, kann Ammoniumchlorid sowie schwefelsaures Ammonium als Stickstoffquelle und Ethylalkohol als Kohlenstoffquelle benutzen. Sporenbildung z. B. auf die mit Kojiwasser getränkte Gipsblocke. Sporenkeimung ganz dieselbe wie bei anderen *Zygosaccharomyces*-arten. Gutes Aroma auf Kojiagar.

Herr Y. NISIWAKI hat aus dem schwarzen Niederschlage japanischer Sake eine Hefe erhalten, welche er *Zygosaccharomyces japonicus* genannt hat. Nach ihm verschmelzen zur Keimungszeit grösstenteils die Sporen zu zweien; auch sind die Promyzelien produziert, von denen die Spitzen schwellen und neue Zellen erzeugen, und zwar durch eine unvollständige Sprossung, wie es bei *Zygosaccharomyces* der Fall ist. Durch die Liebenswürdigkeit von Herrn NISIWAKI hat der Verf. diese Hefe bekommen. Nach seinen eigenen Untersuchungen ist die Keimungsweise dieser Hefeart keineswegs von derselben bei *Zygosaccharomyces* verschieden, ebensowenig kann er die Produktion der Promyzelien nachweisen. Er kommt daher zum Schlusse, dass diese Hefe nicht unter *Zygosaccharomyces* zu rechnen, sondern als eine *Zygosaccharomyces*-art aufzufassen ist. Verf.

329. On a Property of Twining Plants. (Japanese with an English résumé)* Seitaro SUZUKI, Takeo NAGASAWA, Fukuyoshi OMORI. (Bult. Sc. Fak. Terk., Kjušu Imp. Univ. **2**, 1927, 155-168, 1 pl.)

In the present paper the authors publish the following theory concerning the growth of the twining plants along the supporting rod, namely, that a twining plant has a special property for climbing the support with a definite curvature, regardless of the thickness of the latter.

The formula obtained ist.

$$\frac{h^2}{4\pi r} = \text{constant} = \rho$$

where h is the pitch of the spiral, r the radius of the support. The theory was confirmed experimentally in the following plants: *Pharbitis Nil*, *Quamoclit vulgaris* (3.9 cm), *Ipomoea bona-nox* (5.1 cm), and *Dioscorea tenuipes* (17.6 cm). (The figures within the parentheses denote the critical radii). Authors.

330. Experiments on the Eggs of Sargassum. Masato TAHARA. (Bot. Mag. Tôkyô **41**, 1927, 142-148, 3 figs.)

The author has lately published the fact that the egg of *Sargassum* discharged from the conceptacle is either in 8- or 2-nucleate stage. In normal cases one of the eight nuclei is fertilized, while the remaining seven degenerate (s. Japan. Jour. Bot. **3**, 1926, (25), No. 75).

The following experiments were made on the eggs of *S. enerve* and *Horneri*. The eggs in 8-nucleate stage were put for a certain duration of time in a hypertonic water containing KCl, which was afterwards replaced by normal sea-water. In the eggs treated in this way no nuclei degeneration occurred in many cases, and the cell-wall formation began to take place. The result was the production of embryos which may evidently be considered as the fusion product of several embryos. Anomalies were often observed, of which the following are most interesting: the half-embryo which consists of partly of segmented and partly of unsegmented portions, and the embryo where the rhizoid formation takes place in its several regions.

331. Bastardierung als eine Ursache für die Entstehung der Chromosomenpolyloidie. I. Masato TAHARA und Naomasa SHIMOTOMAI. (Sc. Rpts. Tôhoku Imp. Univ. IV. Ser. **2**, 1927, 293-299, 4 Textabbild).

Die Bastardierung *Chrysanthemum marginatum* ♀ (haploide Chromosomenzahl =45) × *C. lavandulaefolium* (9) wurde ausgeführt. Im F₁-Bastard sind bei heterotypischer Teilung der Pollenmutterzellen 36 Gemini aufgetreten, während bei somatischer Teilung in der Wurzelspitze 72 Chromosomen gezählt wurden. Nach der Ansicht der Verf. dürfte die Steigerung der Chromosomenzahl dadurch herbeigeführt werden, dass in der Eizelle gleich nach der Befruchtung 9 Chromosomen aus *Lavandulaefolium* und 9 Chromosomen aus *Marginatum* sich verdoppelt haben, sodass unter 72 Chromosomen des Bastards 54 (=36+9×2) aus *Marginatum* und 18 (=9×2) aus *Lavandulaefolium* abstammen dürften.

332. Some Observations on the Chromosome of *Najas major*, All. Noboru TAKAMINE. (Bot. Mag. Tôkyô **41**, 1927, 118-122, 1 pl. and fig.)

In *Najas major* the author has counted 6 and 12 chromosomes in haploid and diploid cells respectively. The chromosomes are different in shape and length: one of them is V-shaped and longest (13-14 μ), one is very short (3-4 μ), another is somewhat longer (5-6 μ), while the remaining three are intermediate in length (8-10 μ). In the latter three constrictions are sometimes found, and even sometimes 7 chromosomes are present, one of which may be regarded as the satellite detached from one of these three chromosomes. No clear differentiation in chromosomes in respect to sex is observed in the maturation divisions of pollen mother cells, nor is any difference in size and number of chromosomes in somatic cells found between male and female plants.

333. Investigations on the Relation between Plants and their Surrounding Conditions by the Quantitative Method. II. On the Ecological Value of the Results of studying the Interrelation between Water-absorption and Transpiration of Plants. (Japanese with an English résumé). Makoto TAKENOUCHI. (Bul. Sc. Fak. Terk., Kjusû Imp. Univ. **2**, 1927, 213-231, 1 fig.)

The interrelation between water-absorption of roots and transpiration of shoots was studied on a few plants of different ecological types, viz. *Atriplex littoralis* var. *angustissima*, *Aster Tripolium*, *Celosia cristata*, *Bidens bipinnata* and *Sedum viride*.

A little potometer designed after PFEFFER's was used for the experiments, which were performed in every case side by side with well- and sea-water in a chamber with

little variation of temperature. The readings of the results were made once a day. Each value thus found was converted into the relative value for the unit volume of the tissue powder, the unit dry weight of plants and the unit leaf surface, and then into the value relative to the evaporation value of the atomometer. The calculated values are called those for "relative absorption" and "relative transpiration."

The principal results are as follows :—

1. Both values of relative absorption and transpiration, as well as their sum are largest in the mesophytes, smaller in the halophytes, and smallest in the ordinary succulent plants (*Sedum*) in both media.
2. The ratio of the value for relative absorption to that for relative transpiration is largest in the halophytes and smallest in the ordinary succulent plants when the experiment is made with well-water.
3. When sea-water is used this ratio is larger in the ordinary succulent plants than in the mesophytes, the ratio in the halophytes being largest, just as in 2.

Author.

334. On the Genetical Formulae of the Length of Spikes and Awns in Barley, with Reference to the Computation of the Valency of the Hereditary Factors. (Japanese). Yosinori TAKEZAKI. (Rpt. Agric. Exp.-Sta. Tōkyō No. 46, 1927, 43 pp. and 3 pls.)

The experiments described in this paper were performed on 180 Japanese strains of Barley. The spike lengths are divisible into three classes, short, middle and long, and the awn lengths into four classes, short, middle, middle-long, and long. The spike length is determined by various combinations of two allelomorphic pairs **E**, **e**, and **H**, **h**, and the awn length by those of three allelomorphic pairs **E**, **e**, **A**, **a**, and **H**, **h**. The awn is either hard or soft. Dominancy of one allelomorph to the corresponding one is perfect, so that there are no quantitative difference between the corresponding homo- and heterozygotes.

The most significant fact found by the author is that the lengths of spikes and awns are determined by the basic value multiplied by the respective values of the dominant factors concerned. For instance, according to the calculation of the author the basic value of the awn, i. e. of that with no dominant factors or **eeaa hh**, is 14.40, and the valencies of **E**, **A** and **H** are 1.087, 1.687, and 1.909 respectively. The length of the awn **eeAAhh** should belong to the middle class and theoretically be equal to $14.40 \times 1.687 = 24.30$, that of the awn **EEAAhh** should also belong to the middle class and be equal to $14.40 \times 1.087 \times 1.687 = 26.42$, while that of the awn **EEAAHH** should belong to the long class and be equal to $14.40 \times 1.087 \times 1.687 \times 1.909 = 50.41$. The computations just described as well as the actual measurement of the lengths were made by the author on many thousands of spikes and awns of all strains and their hybrids. The theoretical numbers were found always to be in agreement with the actual values with certain errors which are within the limits as allowed by the theory.

Many other interesting facts mentioned in this paper are naturally impossible to be noticed in this short abstract. The details should be read in the original paper.

335. Bacterial Disease of Petasites. Seito TAKIMOTO. (Ann. Phytopathol. Soc. Japan 2, No. 1, 1927, 53-56 with a Japanese résumé).

The disease appears on leaves of *Petasites japonicus* at first as small circular brown spots which gradually enlarge, till the spots turn black and leaves become like a rag. The causal organism is a new species, *Bacterium Petasitis*. The inoculation experiments were performed with positive results. Its diagnosis is as follows: short, rapidly growing rod with rounded ends, with a polar flagellum, single or paired; $1.1-1.7\mu \times 0.8-1.0\mu$ in average; neither spore, capsule, zooglea nor involution form ever observed; GRAM negativ; stains readily by gentian violet and methylen blue; facultative aerobic. Colonies on beef agar white, circular or amoeboid, flat, with entire margins; smooth surface and butyrous consistency; gelatine not liquefied; milk curdled in 30 days; litmus whey reduced; indol not produced; gas formed; nitrates reduced; slight diastasic action on potato plate; good growth in USCHINSKY's solution; max. temperature for growth 47°C , opt. $27-30^{\circ}\text{C}$, thermal death point $55-56^{\circ}\text{C}$; not sensitive to dryness, destroyed after 3 hrs. exposure to bright sunshine; long vitality on culture media. Pathogenic on leaves of *Petasites japonicus*.

336. Studien über die Stoffwechselphysiologie von *Aspergillus oryzae*. I.
Hiroshi TAMIYA. [Acta Phytochimica, 3, 1927, 51-173, 30 Fig.]

In der vorliegenden Mitteilung behandelt Verf. den Einfluss verschiedener organischer und anorganischer Säuren auf das Wachstum und die Kojisäurebildung von *Aspergillus oryzae*. Die Kojisäureanhäufung in der Kulturlösung von *Aspergillus oryzae* ruft eine nur sehr geringe Steigerung der H-Ionenkonzentration hervor. Die beobachtete Aciditätsänderung der Kulturlösung kann also fast ausschliesslich auf die Nährsalzverzehrung des Pilzes zurückgeführt werden. Bei der Kultur mit verschiedener Anfangs-pH konnte Verf. sicherstellen, dass der Pilz in Kulturlösungen mit höherer H-Ionenkonzentration grössere Affinität gegen Anionen als gegen Kationen zeigt; in Kulturlösungen mit niedriger H-Ionenkonzentration findet das umgekehrte statt. Dasselbe gilt besonders für die als N-Quelle dargereichten Ammonium- und Nitrationen, obwohl Ammonium im allgemeinen eine bessere Nährwirkung zeigt. Demzufolge wird die Acidität der Kulturlösung von dem Pilz reguliert und schliesslich zu einem gewissen Wert gebracht, der hierbei dem bei Eiweisskörpern oft beobachteten isoelektrischen Punkt nahe steht. Bei gewöhnlichen Kulturbedingungen ist das Grenz-pH für das Auskeimen des Pilzes in saurem Medium pH 2. 1, und in alkalischem pH 8.5-8.7, während ein maximales Myzelwachstum immer bei zwei verschiedenen pH-Werten (nämlich bei etwa pH 3.5 und bei etwa pH 7) und ein vermindertes Wachstum dazwischen (nämlich bei etwa pH 5.5) beobachtet wird. Die Aciditätsgrenze und der Verlauf der pH-Wachstum-Kurve variieren je nach der Zusammensetzung der Kulturlösung, was wohl auf die korrelativen Wirkungen der Wasserstoffionen und anderen Ionen sowie Molekülen zurückzuführen ist. Ein Zusatz von verschiedenen Säuren beeinflusst in verschiedener Weise das Wachstum, die Säurebildung sowie auch andere Lebenstätigkeiten der Pilze. Im allgemeinen wirken die organischen Säuren schädlich, wenn sie als freie Säure (Moleküle) vorhanden sind, obwohl sie sich als wachstumsbeschleunigend in Form der Salze (Anionen) zeigen. Die wachstumsbeschleunigende Wirkung in der gebundenen Form ist am bedeutendsten bei Oxal-, Citronen- und Kojisäure; darauf folgt Wein-, Milch-, Essig-, Ameisensäure. Die zwei letzteren Säuren sind sehr giftig in freier Molekülform, sodass

die pH-Grenze für das Pilzwachstum bis zu 4.5 erniedrigt wird. Unter den anorganischen Säuren ergeben Phosphor- und Schwefelsäure ein besseres Pilzwachstum als Salpeter- und Salzsäure. Die Kojisäurebildung wird von einem Oxal- und Citronensäurezusatz stark gehemmt, jedoch von Essig-, Ameisen-, Salz- und Salpetersäure nicht sehr affiziert, während sie von Schwefelsäure etwas beschleunigt wird. Eine erhöhte Kojisäureproduktion wird von Weinsäure bei niedriger H-Ionenkonzentration bewirkt, und auch von Phosphor-, Milch- sowie Brenztraubensäure, besonders stark bei einem Medium mit pH 5-6. Die wachstumsbeschleunigende Wirkung der Oxal-, Citronen- und Kojisäure bedingt nach dem Verf. das Zustandekommen des autokatalyseähnlichen Verlaufes des Pilzwachstums. Die ökonomischen Koeffizienten, welche sich immer der Kojisäureproduktivität entgegen verhalten, sind im früheren Stadium der Pilzentwicklung grösser und nehmen mit der Anhäufung der Kojisäure allmählich ab. Die Kojisäurebildung wird ferner durch Nährsalz-, insbesondere N-Mangel der Kulturlösung stark befördert.

Verf.

337. On the Orange of Wênchow, China. (Japanese with an English résumé). Tyôzaburô TANAKA. (Agric. & Hortic. **1**, 1926, 15-26, 1 pl.)

The orange of Wênchow, China, much esteemed on account of its excellent pulp especially by the opium smokers, is described. It occurs nowhere else in China. The Japanese *Citrus unshiu* hort. might be a chance seedling originated in Kyushû from the seeds of some allied Chinese species of mandarin.

338. Wild Citri of the Japanese Territories. (Japanese with an English résumé). Tyôzaburo TANAKA. (Bult. Sc. Fak. Terk., Kjušu Imp. Univ. **2**, 1926, 51-58).

In Japan there are several wild species of *Citrus*, of which the author enumerates the following: *C. tachibana* TANAKA, *C. depressa* HAYATA, *C. taiwanica* TANAKA et SHIMADA. *C. goganensis* HAYATA is an albino citron escaped from cultivation and may be called *C. medica goganensis* n. comb.

339. On the Scientific Name of Washington Navel Orange. (Japanese with an English résumé). Tyôzaburô TANAKA. (Bult. Sc. Fak. Terk., Kjušu Imp. Univ. **2**, 1926, 83-95).

The following new varietal names are proposed for Washington Navel Orange: *Citrus sinensis brasiliensis* for Washington Navel Orange (Brazilian origin), *C. s. algeriensis* for Navel algérienne (Algerian origin), *C. s. fetifera* for orange double de Nice (French origin), *C. s. duplex* for oranger à fleur double (French origin), *C. s. umbilicata* for oranger ombril (French origin).

340. On the Scientific Name of Grape-fruit. (Japanese with an English résumé). Tyôzaburô TANAKA. (Bult. Sc. Fak. Terk., Kjušu Imp. Univ. **2**, 1926, 67-73 with fig.)

Different scientific names were given to the grape-fruit, but the author thinks that the name *Citrus paradisi* MACF. is its only correct name.

341. On Citrus Coji Markovich. (Japanese with an English résumé). Tyôzaburo TANAKA. (Bult. Sc. Fak. Terk., Kjušu Imp. Univ. **3**, 1927, 190-199).

The name *Citrus Coji* given in 1921 by MARCOVITCH to the orange Kôzi (in Japanese) includes really several types. The author considers it to be a horticultural species with no wild representative and calls it *C. leiocarpa* hort.

342. Studies on the Correlations between Morphological Characters, Chromosome-number and Resistance to Puccinia triticina in Pentaploid-bastards of Wheat. Yoshihiko TOCHINAI and Hitoshi KIHARA. (Jour. Coll. Agric., Hokkaido Imp. Univ. **17**, 1927, 133-161).

Former investigations on the relationship between the genetical characters and the rust-resistance of wheat have been carried out mostly on *Puccinia graminis* and *P. glumarum*, and a little on *P. triticina*. In the present studies, however, the authors have laid stress upon *P. triticina* as well as upon *P. graminis*.

Systematic grouping of wheat arranged by SCHULZ coincides perfectly with the results of phytopathological, serological and cytological studies obtained by VAVILOV, ZADE and SAKAMURA respectively. Our observations on the resistance and susceptibility of 9 species of *Triticum* and 3 species of *Aegilops* to *P. triticina* and *P. graminis* coincide well with the results reported by VAVILOV. Three species of *Aegilops*, which has a close relationship to *Triticum* are strongly resistant to both rust-fungi, but not immune as *T. monococcum*.

On the rust-resistance of F_4 -generation of wheat-hybrids, the most interesting case is that of *T. durum* \times *T. vulgare*. In general, the segregates having 28 or 29 chromosomes and durum-like morphological characters are mostly resistant, while others having vulgare-like appearance and the approximate number of chromosomes to *T. vulgare* are susceptible to both rust-fungi. The degree of the resistance or susceptibility, however, changes in some extent according to the strains of the hybrids. F_4 -generation of the hybrids of *T. polonicum* and *T. Spelta* having mostly *Spelta*-like shape and approximately or just 42 chromosomes are unusually susceptible to the attack of *P. triticina*. It is noteworthy that the descendants in the crosses of somewhat rust-resistant *T. polynicum* and susceptible *T. Spelta* are far weaker to the rust-fungi than the susceptible parent. F_4 -generation of the hybrids of *T. turgidum* and *T. compactum*, being similar to or like *T. compactum* in their morphological characters and chromosome-number, are generally as susceptible to both rust-fungi as their susceptible parent.

In the crossing of Emmer-wheat and Dinkel-wheat, the combination of the chromosomes of the parents conforms to certain rules. F_1 -hybrid has 35 ($14_b + 7_i$) chromosomes, and in the following generations, the chromosome-number of the descendant plants increasing to 42 or decreasing to 28, the chromosome-combination becomes homozygous when the number of chromosomes coincides with that of parents, *i. e.* 42 or 28. It is important to notice that the chromosome-number increases slowly and decreases rapidly in advancing generation of the hybrids. Such fluctuation of the number of chromosomes resulted from casting off or from duplication of 7 chromosomes which were univalent in F_1 -plants. The resistance of wheat to rust-fungi seems to be weakened by the presence of genes existing in these 7 chromosomes. Accordingly, a rust-resistant wheat strain will rarely be obtained by

means of crossing Emmer- and Dinkel-wheats, though not impossible. In the authors' view, the best practical means of breeding rust-resistant wheat may be found in selection and crossing among comparatively resistant races of *T. vulgare*. Further investigations on the descendants of the pentaploid-bastards of wheat, however, are both very necessary and interesting in the studies on rust-resistant wheat.

TOCHINAI.

343. On Double-flowering Yellow Rhododendron (*Rhododendron chrysanthum* Pall, forma *senanense*, Yabe). (Japanese). Yositada YABE. (Bot. Mag. Tôkyô **41**, 1927, 271–273, 2 pls.)

Rhododendron chrysanthum PALLA is a yellow-flowering species widely distributed throughout Northern Japan, but its double-flowering forma *senanense* YABE is found only in Mt. Yatsugatake in Central Japan in places 2700–2800 m. above sea-level. The doubleness is due to the change of stamens into petals. Ripe fruits seem to be produced. Some anomalies may be mentioned: corolla is often 6-lobed instead of being 5-lobed, 10 stamens are often fused into one, in which case the anthers either contain pollen or are empty.

344. Kreuzungsuntersuchungen an Reispflanzen. I. Genetische Analyse der Granne, der Spelzenfarbe und der Endospermbeschaffenheit bei einigen Sorten des Reises. Yasuke YAMAGUCHI. (Ber. d. Ôhara Institut f. landw. Forsch., **3**, 1926, 1–126, mit 1 Tafel.)

Die Ergebnisse der genetischen Untersuchungen sind erstens über die Begrannung durch Kreuzung zwischen den Sorten "Omati" und "Sinriki" und zweitens über die Spelzenfarbe und Endospermbeschaffenheit durch Kreuzung zwischen den Sorten "Sinriki" und "Karasumoti" mitgeteilt worden.

Die Begrannung, qualitativ betrachtet, dominiert über die Grannenlosigkeit. Wegen der grossen Variation in bezug auf die Grannenlänge und die Anzahl bzw. den Prozentsatz der begranneten Körner sowohl bei F_1 -Pflanze als auch bei den in der F_3 -Generation aufgespalteten Pflanzen hielt der Verf. die Beteiligung der polymeren Gene bei der Grannenentwicklung dieser Pflanze höchst wahrscheinlich.

Sorgfältig und umfangreich durchgeführte Untersuchungen über die Spelzenfarbe und Endospermbeschaffenheit, deren Mitteilung den grössten Teil dieses Aufsatzes einnimmt, bestätigten und vertieften die frühere Ansicht des Verf. [vergl. Jap. Journ. Bot., **1** (15)–(16), Abstract 38]. Durch die Prüfung des gegenseitigen Verhältnisses der in Frage kommenden vier Gene ist eine Koppelung zwischen dem Gen **S** für die rötliche Farbe der Spelzenspitze und der ganzen Hüllspelze und dem Gen **M** für die Endospermbeschaffenheit festgestellt worden. Der Austauschwert beträgt dabei 20–22%, mit der Ausnahme bei einer Linie, wo er 7,80% beträgt. Sie ist **S-M**-Koppelungsgruppe genannt worden. Überdies zwischen der Blütezeit und der Endospermbeschaffenheit existiert eine Korrelation.

Verf.

345. Kreuzungsuntersuchungen an Reispflanzen. II. Ueber die zweite (S-M-) Koppelungsgruppe mit besonderer Berücksichtigung ihrer korrelativen Beziehung zur Blütezeit. (Vorläufige Mitteilung). Yasuke YAMAGUCHI. (Ibid. **3**, 1927, 319–230.)

Durch die planmässigen Kreuzungen ist die im vorigen Aufsätze mitgeteilte Koppelung, neben der korrelativen Beziehung derselben zur Blütezeit weiter untersucht worden. Nach weiteren Ergebnissen sind zwischen den Genen **S** und **M** die zwei ganz verschiedenen Austauschwerte von etwa 7% und 21% festgestellt worden. Ob diese Tatsache dem Vorhandensein der Gene **S**₁ und **S**₂ statt **S**₁ wie im vorigen Aufsätze gefolgert wurde, zu verdanken wäre, ist noch zu forschen.

Zwischen dem einen Gen **Fx** für die Blütezeit und dem **M** für die Endospermbeschaffenheit findet sich auch eine unvollkommene Koppelung, wobei der Austauschwert bei einem Falle 24% und bei einem anderen 15% beträgt. Ebenso eine Koppelung mit einem Austauschwerte von etwa 24% wurde zwischen den Genen **S** und **Fx** festgestellt. So ist es fast zweifellos, dass das eine Gen für die Blütezeit zur **S-M**-Koppelungsgruppe gehören kann. In dem in Frage kommenden Chromosom können sie sich in der Reihenfolge von **S-M-Fx** (oder in der umgekehrten) befinden.

Verf. diskutiert die Möglichkeit, dass die Schwankungen des Zahlenverhältnisses zwischen Stärke- und Dextrinendosperm durch das eine letale Gen bedingt sein können, welches ebenfalls zu dieser Koppelungsgruppe gehört. Verf.

346. Notiz über die Vererbung der Fasziation bei *Pharbitis Nil*. Yasuke YAMAGUCHI. (Bot. Mag. Tōkyō, **40**, 1926, 535–537.)

Die Annahme HAGIWARA's war, dass das Auftreten fasziierter Pflanzen bei *Pharbitis Nil* von 2 Genen, ein **f'** für Fasziation selbst und ein **p** für Blattform, bedingt sein soll. Nach den Ergebnissen eigener Untersuchung nimmt der Verf. dagegen zwischen dem einen Gen für Fasziation und dem Gen für Blattform eine Koppelung an, wobei der Austauschwert etwa 4% betragen wird. Verf.

(S. Jap. Jour. Bot. **3**, (46), No. 135.—Redaktion.)

347. Supplementa Iconum Plantarum Formosanarum III. Yoshimatsu YAMAMOTO. Taihoku 1927, 48 S. und 2 Tafeln.

Die folgenden Arten und Varietäten usw. sind grösstenteils beschrieben und teilweise illustriert: *Amentotaxus argotaenia* (HANCE) PILGER, *Dioscorea alata* L., *D. Bentharii* PRAIN et BURKILL., *D. bulbifera* L., *D. Collettii* HOOK. fil., *D. doryophora* HANCE, *D. formosana* R. KNUTH, *D. japonica* THUNB., var. *kelungensis* (R. KNUTH) PRAIN et BURKILL., *D. persimilis* PRAIN et BURKILL., *D. rhipogonoides* OLIVER, *D. triphylla* L., var. *reticulata* PRAIN et BURKILL., *Goodyera Ogatai* YAMAMOTO sp. nov., *Lithocarpus suishanensis* KANEHIRA et YAMAMOTO, sp. nov., *Ficus Nagayamai* YAMAMOTO, sp. nov., *Loranthus daibuzanensis* YAMAMOTO sp. nov., *L. niitakayamensis* YAMAMOTO sp. nov., *L. pseudochinensis* YAMAMOTO sp. nov., *Viscum coloratum* (KOMAROV) NAKAI, *Achyranthes obtusifolia* LAMARCH, *A. aspera* L., *A. rubrofusca* WIGHT, *A. longifolia* MAKINO, *A. Ogatai* YAMAMOTO sp. nov., *Coptis quinquefolia* MIQ., f. *ramosa*, *Anemone Taraoi* (MAKINO) TAKEDA, var. *Morii* YAMAMOTO var. nov., *Anemone vitifolia* BUCH.-HAM. var. *Matsudai* YAMAMOTO var. nov., *Ranunculus biternatus* SMITH, *R. japonicus* THUNB., var. *yakushimensis* (MAKINO) YAMAMOTO, *R. ternatus* THUNB., *R. Vernyi* FRANCH. et SAV., *Stephania cepharantha* HAYATA, *S. japonica* (THUNB.) MIERS, var. *hispidula* YAMAMOTO var. nov., *S. tetrandra* S. MOORE, *Polyalthia Sasakii* YAMAMOTO sp. nov., *Eurya ochracea* SZYZ.,

Scolopia crenata CLOS, *Homalium fagifolium* BENTH., var. *pseudopaniculatum* YAMAMOTO var. nov., *Xylosma japonica* A. GRAY, *Idesia polycarpa* MAXIM., *Casearia Merrilli* HAYATA.

348. On the Winter-Hardness of Barley. I. On the Relation between the Winter-hardness and the Monosaccharose Content. (Japanese with an English résumé). Sadao YASUDA. (Jour. Sc. Agric. Soc. No. 288, 1926, 486-493).

The results of the author's studies are as follows:—

- 1) When one and the same race is cultivated under different temperature the sugar content was observed to increase with cold and vice versa.
- 2) The hardier varieties contain the larger amount of sugar than the less hardy ones under the same condition.
- 3) As far as the author's experiments have shown, the increase of sugar content seems to take place more rapidly in the hardier varieties than in the less hardy ones.
- 4) In the individual plant the less hardy parts contain less amount of sugar than the hardier ones.

Author.

349. On the Winter-Hardness of Barley. II. Effect of Potassium Salts. (Japanese). Sadao YASUDA. (Jour. Sc. Agric. Soc. No 295, 1927, 273-281).

The results of the author's experiments are as follows:

- 1) The deficiency of potassium inhibits the formation of sugar, and consequently the plants become less hardy:
- 2) A high application of potassium under low temperature increases the sugar content of the plants, which become consequently hardier against cold.
- 3) Under the condition of an ordinary green house the high application of potassium induces the rapid growth of plants, thereby causing the decrease of the sugar content.
- 4) The effect of potassium for increasing sugar content becomes noticeable two or three days after its application.

Author.

350. Physiological Researches on the Fertility in *Petunia violacea*. I-II. (Japanese with an English résumé). Sadao YASUDA. (Bot. Mag, Tôkyô 41, 1927, 17-27 and 438-449).

The author has made a series of experiments in order to compare the results of pollination when this is performed in different ways, viz. self-pollination (autogamy), neighbour-pollination (geitonogamy) and that between individuals of the same vegetative line.

The comparison of the results of pollination between self- and neighbour-pollination has shown that the latter mode gives in many respects the better results than the former: when the neighbour-pollination is practised, the fertilization is more successful, flowers fade away much earlier, the ovaries, even when unfertilized, are much larger, the capsules derived from the fertilized ovaries contain a larger number of seeds, the seeds are larger and heavier, and the seedlings are longer than when the self-pollination is practised.

Furthermore, when the pollination is performed between one plant and another derived from its cutting it was found that the fertilizing percentage, the size of the unfertilized ovaries, that of the capsules, the number, size, weight as well as the germination percentage of seeds, the length of seedlings—all are larger than in the case of self- and neighbour-pollination.

When the pollination is done between the scions of the same vegetative line cultivated under a similar condition of humidity, either dry or moist, the results of pollination are better than in the case of self- and neighbour-pollination. And when the pollination is done between the scions of the same vegetative line cultivated under the opposite conditions of humidity (one dry, another moist), the results are much better than in the case of pollination between the scions under the same condition of humidity.

351. Further Studies on Genetics and Cytology of Artificially Raised Hybrids of Papaver. Kono YASUI. (Bot. Mag., Tôkyô **41**, 1927, 235-261, 14 text-figs.)

Of the artificially raised F_1 -hybrids between *Papaver somniferum* var. *glabrum* and *P. nudicaule* those only in which the former species is the seed-plant is fertile, though partially and very slightly.

The F_1 -hybrids are intermediate between the two parents in several respects, though also in some points there is the dominance of one allelomorph to the corresponding one, for instance, the perennial character of ♂ plant recessive to the annual one of ♀. The male and female parents have 14 and 22 diploid chromosomes respectively. The F_1 -plants have 18 chromosomes (=11+7), of which 6 or 8 form the gamete, so that in the pollen mother-cells there are 3 or 4 bivalents and 10 or 12 univalents. In the offspring derived from the F_1 -hybrids backcrossed by *P. somniferum* var. *glabrum* there are 11 bivalents and only 5-7 univalents, and in the F_3 -offspring most individuals showed 11 bivalent chromosomes with no univalents at all. Corresponding to such elimination of the univalents in the F_2 - and F_3 -generation the author could observe the restitution of many maternal characters in these generations, so that the univalent chromosomes should mostly belong to *P. nudicaule*.

The segregation of the allelomorphs, lacinate—entire, purple patch—white patch (first dominant, second recessive) is not so regular in F_3 as in the usual Mendelian case, because the ratios seen in the offspring point toward the reversal of dominance, entire—lacinate, white patch—purple patch. The author thinks that the fact is due, not only to the irregular behavior of chromosomes in meiosis, but also to the interchange of the genes concerning such characters which might occur in the successive generations.

352. On the Hypochynus-disease of Soy-beans and its Comparison with that of Rice-plants. (Japanese). Kuniomi YOKOGI. (Jour. Plant Prot. **14**, 1927, 12 pp., 2 figs.)

Both *Hypochynus Sasakii* SHIRAI and *H. centrifugus* (LÉV.) TUL. are known to be pathogenic to soy-beans. The fact was confirmed by the inoculation experiments. Further, inoculation experiments of *H. Sasakii* from rice-plants on soy-beans and the reverse experiments were performed with positive results. Besides, the comparative

experiments of the fungi from soy-beans as well as rice-plants have shown that between the two there are no significant differences, so that both fungi may be surely considered to belong to one and the same species.

Minimum temperature for the growth of *H. centrifugus* somewhat lower than 10°C, optimum $\pm 30^\circ\text{C}$, maximum $\pm 41^\circ\text{C}$, optimum for sclerotia formation $\pm 28^\circ$.

353. Studies on the Hypochnus-disease of Sesamum indicum and the Pathogenicity of its Causal Organism to Rice-plants and Soy-beans. (Japanese). Kuniomi YOKOGI. (Agric. & Hortic. **2**, 1927, 487-500, 1 pl., 2 figs.)

The culture of *Hypochnus centrifugus* (LÉV.) TUL., the causal organism of the so-called "white silk disease" of *Sesamum indicum* on some artificial media was made. Maximum temperature for its growth 41°C, optimum 28-32°C, minimum under 10°C. In dark places the sclerotia formation is not significant, while the mycelium grows then very well. The organism is pathogenic also to rice-plants and soy-beans.

354. Über die schädlichen Wirkungen der schwefligen Säure auf die Pflanzen. (Japanisch). Tyûtarô YONEMARU. (Mitteil. Versuchsst. Tôkyô, Nr. **47**, 1927, 102 S. und 5 Tafeln).

Eine Reihe von Versuchen wurden ausgeführt, um die Schädlichkeit schwefliger Säuren auf die Pflanzen ausführlich zu studieren. Die für Versuche benutzten Pflanzen sind die Zerealien, Gemüse- und Küchenpflanzen, Obstbäume, Nadel- und Laubbäume, Unkräuter usw., im ganzen mehr als 65 Arten. Die Luft, welche $\frac{1}{10\,000} - \frac{1}{1\,000\,000}$ ihres Volumens an schwefliger Säure enthält, wurde während gewissen Zeitdauern ($\frac{1}{2}$ —1 Stunde) mit den zu untersuchenden Pflanzen in Berührung gebracht. Es wurde dabei vor Allem festgestellt, dass das schädliche Effekt nur bei den dem direkten Sonnenlichte ausgesetzten Pflanzen zu erkennen ist, nicht aber bei denselben im Dunkelkammer oder während des Nachts. Der Verf. ist der Meinung, dass die Schädlichkeit der schwefligen Säure nicht der Einwirkung der letzteren als solcher zu verdanken ist. Es ist bekannt, dass die durch die Atmung entstandenen organischen Säuren durch Spaltung gewisse Aldehyden produzieren können. Der Verf. glaubt, dass die durch die Verbindung von schwefligen Säuren mit solchen Aldehyden entstandenen α -Oxysulfosäure $\text{C} \begin{smallmatrix} \text{OH} \\ \text{SO}_3\text{H} \end{smallmatrix}$ auf die Pflanzen direkt schädlich einwirkt. Die oben erwähnte Tatsache, dass die Schädlichkeit nur unter dem direkten Sonnenlichte anzuerkennen ist, ist darauf zurückzuführen, dass das Licht bei der Spaltung der organischen Säuren eine wichtige Rolle spielt, insofern als es diesen Vorgang beschleunigt. Der Beweis für die oben erwähnte Hypothese ist wie folgt. Der Verf. hat auf die im Dunkelkammer gesetzten Pflanzen während 30 Min. schweflige Säure oder Formaldehyd einzeln einwirken lassen, ohne nachher gar keine schädliche Effekte zu bemerken, aber wenn er denselben Pflanzen Säure und Aldehyd gleichzeitig oder unmittelbar nacheinander hat einwirken lassen, kann er erst deutlich solches Effekt beobachten.

Die Pforten für das Eindringen der schwefligen Säure im Pflanzeninnere sind die Spaltöffnungen und Wasserporen, denn die mit Vaseline bestrichenen Pflanzenteile sind gar keine Wirkung des Gases unterlegen.

Es ist bekannt, dass die Schädlichkeit der schwefligen Säure viel bedeutender beim feuchten als beim trockenen Wetter ist: durch die Absorption des Wassers wird das Gas im feinen tautropfenartigen Zustand versetzt, woraus es ziemlich konzentriert wird und wegen der langsamen Beweglichkeit es leicht an verschiedenen Pflanzenteilen lange bleiben und dementsprechend grosse Schaden verursachen kann.

Die Schädlichkeit bei den Kulturpflanzen ist natürlich nach den Umständen verschieden: Pflanzenarten, Saison, Zeitdauer der Einwirkung, Düngung, Konzentration des Gases usw. usw. Die Konzentration, welche grösser als $\frac{5}{1\,000\,000}$ ist, ist schon schädlich. Die Schädlichkeit ist am grössten, wenn die Gaseinwirkung kurz vor oder nach der Blütenperiode stattfindet.

Zu der Arbeit sind eine grosse Anzahl von Tabellen angegeben, welche die Resultate der umfangreichen Versuchen des Verfs. verdeutlichen.

355. Additamenta ad Lichenographiam Japoniae. A. ZAHLBRÜCKNER.
Bot. Mag. Tōkyō **41**, 1927, 313-364).

208 in verschiedenen Gegenden Japans gesammelte Flechtenarten sind hervorgehoben und meistens beschrieben. Die folgenden sind neue Arten: *Clathroporina japonica*, *Blastodesmia albonigra*, *Polybastiopsis bella*, *Pyrenula oblonga*, *Lecanactis macrocarpa*, *Schismatomma caesitium*, *Thelotema Fauriei*, *Leptotrema oleosum*, *L. inclusum*, *Byssoloma expansum*, *Phylliscum japonicum*, *Collema idzuense*, *Erioderma Asahinae*, *Lecidea caesiororida*, *L. rosulata*, *L. nipponica*, *L. Asahinae*, *Catillaria yezoensis*, *C. melanocarpa*, *Bacidia phaeoplaca*, *Lopadium purpuratum*, *Baeomyces insignis*, *Glossodium japonicum*, *Stereocaulon prostratum*, *Perusaria phaeophthalma*, *Lecanora mutsuana*, *L. tunixata*, *L. lecanactina*, *Haematomma polycarpum*, *Parmelia nikkoensis*, *P. hakonensis*, *P. diffugiens*, *P. shinanoana*, *P. cochleata*, *P. nipponica*, *Ramalina Asahinana*, *Siphula fuscidula*, *Bombyliospora japonica*, *Rinodina luteonigra*, *R. melancholica*, *Physcia Faurieana*.

